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NATURAL HISTORY,

GENERAL AND PARTICULAR,

BY THE

COUNT DE BUFFON,

TRANSLATED INTO ENGLISH.

ILLUSTRATED

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AND OCCASIONAL

NOTES AND OBSERVATIONS.

BY WILLIAM SMELLIE,

MEMBER OF THE ANTIQUARIAN AND ROYAL
SOCIETIES OF EDINBURGH.

SECOND EDITION.

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GENERAL

GENERAL HISTORY
OF
A N I M A L S.
CHAPTER I.

Analogies between Animals and Vegetables.

AMONG the numberless objects with which the surface of this globe is covered and peopled, animals hold the first rank, both on account of the relation they bear to man, and of their acknowledged superiority over vegetable and inanimated matter. The senses, the figure, and the motions of animals, bestow on them a more extensive connection with surrounding objects than is possessed by vegetables. The latter, however, from their expansion, their growth, and the variety of parts of which they are composed, are more intimately related to external objects than minerals or stones, which are perfectly inert, and deprived of every vital or active principle.

principle. It is this number of relations alone which render the animal superior to the vegetable, and the vegetable to the mineral. Man, if we estimate him by his material part alone, is superior to the brute creation only from the number of peculiar relations he enjoys by means of his hand and of his tongue; and, though all the operations of the Omnipotent are in themselves equally perfect, the animated being, according to our mode of perception, is the most complete; and man is the most finished and perfect animal.

What a variety of springs, of powers, and of mechanical movements, are included in that small portion of matter of which the body of an animal is composed! What a number of relations, what harmony, what correspondence among the different parts! How many combinations, arrangements, causes, effects, and principles, all conspiring to accomplish the same design! Of these we know nothing but by their results, which are so difficult to comprehend, that they cease only to be miraculous from our habits of inattention and our want of reflection.

But, however admirable this work may appear, the greatest miracle is not exhibited in the individual. It is in the successive renovation, and in the continued duration of the species, that Nature assumes an aspect altogether inconceivable and astonishing. This faculty of reproduction,

duction*, which is peculiar to animals and vegetables; this species of unity which always subsists, and seems to be eternal; this generative power, which is perpetually in action, must, with regard to us, continue to be a mystery so profound, that we shall probably never reach its bottom.

Even inanimate bodies, the stones or the dust under our feet, have some properties; their very existence presupposes a great number; and matter, the most imperfectly organized, possesses many relations with the other parts of the universe. We will not assert, as some philosophers have done, that matter, under whatever form it appears, is conscious of its existence and of its relative powers. This question belongs to metaphysics, of which we intend not to treat. We shall only remark, that, being ignorant of the extent of our own connections with external objects, we cannot hesitate in pronouncing inanimate matter to be infinitely more ignorant. Besides, as our sensations have not the most distant resemblance to the causes which produce them, analogy obliges us to conclude, that dead matter is neither endowed with sentiment, with sensation, nor with a consciousness of its own existence. Hence, to attribute any of

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* This word is frequently used by the author, and requires to be explained. It signifies the power of producing or propagating in general, and is equally applicable to plants and to animals. Generation is a species of reproduction peculiar to animated beings.

these faculties to matter, would be ascribing to it the power of thinking, of acting, and of perceiving, nearly in the same manner as we ourselves think, act, and perceive; which is equally repugnant to reason and religion.

With inanimated matter, therefore, though formed of dust and clay, we have no other relations than what arise from the general properties of bodies, such as, extension, impenetrability, gravity, &c. But, as relations purely material make no internal impression on us, and, as they exist entirely independent of us, they cannot be considered as any part of our being. Our existence, therefore, is an effect of organization, of life, of the soul. Matter, in this view, is not a principal, but an accessory. It is a foreign covering, united to us in a manner unknown; and its presence is noxious. Thought is the constituent principle of our being, and is perhaps totally independent of matter.

We exist, then, without knowing how; and we think, without perceiving the reason of thought. But, whatever be the mode of our being, or of our thinking, whether our sensations be real or apparent, their effects are not the less certain. The train of our ideas, though different from the objects which occasion them, gives rise to genuine affections, and produces in us relations to external objects, which we may regard as real, because they are uniform and invariable. Thus, agreeable to the nature of our being,

being, it is impossible to doubt concerning the reality of those distinctions and resemblances which we perceive in the bodies that surround us. We may, therefore, conclude, without hesitation, that man holds the first rank in the order of nature; and that brute animals hold the second, vegetables the third, and minerals the last. Though we are unable clearly to distinguish between our animal and spiritual qualities; though brutes are endowed with the same senses, the same principles of life and motion, and perform many actions in a manner similar to those of man; yet they have not the same extent of relation to external objects; and, consequently, their resemblance to us fails in numberless particulars. We differ still more from vegetables; but we are more analogous to them than to minerals; for vegetables possess a species of animated organization; but minerals have nothing that approaches to regular organs.

Before we give the history of an animal, it is necessary to have an exact knowledge of the general order of his peculiar relations, and then to distinguish those relations which he enjoys equally with vegetables and minerals. An animal possesses nothing common to the mineral but the general properties of matter: His nature and oeconomy, however, are perfectly different. The mineral is inactive, insensible, subject to every impulse, without organization, or the power of reproduction, a rude mass, fitted only to be trod by the feet of men and of animals.

6 ANALOGIES BETWEEN

Even the most precious metals, which derive their value from the conventions of men only, are regarded in no other light by the philosopher. In the animal, the whole powers of nature are united. The principles with which he is animated are peculiar to him : He wills ; he determines ; he acts ; he communicates, by his senses, with the most distant objects ; his body is a world in miniature, a central point to which every thing in the universe is connected. These are his peculiar and invariable relations : The faculties of growth and expansion, of reproduction and the multiplication of his species, he possesses in common with the vegetable kingdom.

Progressive motion appears, to be the most distinguishing quality between an animal and a vegetable. We, indeed, know no vegetable that enjoys a loco-motive faculty. But this motion is denied to several species of animals, as oysters*, gall-insects, &c. This distinction, therefore, is neither general nor essential.

Sensation more essentially distinguishes animals from vegetables. But *sensation* is a complex idea, and requires some explication ; for, if sensation implied no more than motion consequent upon a stroke or impulse, the sensitive plant enjoys this power. But, if by sensation we mean the faculty of perceiving and of comparing ideas, it is uncertain whether brute animals

* This is not strictly true; for oysters, and even gall-insects, are capable of a degree of local motion.

mals are endowed with this faculty. If it should be allowed to dogs, elephants, &c. whose actions seem to proceed from motives similar to those by which men are actuated, it must be denied to many species of animals, particularly to those that appear not to possess the faculty of progressive motion. If the sensation of an oyster, for example, differ in degree only from that of a dog, why do we not ascribe the same sensation to vegetables, though in a degree still inferior? This distinction, therefore, between the animal and vegetable, is neither sufficiently general nor decided.

A third distinction has been derived from the manner of feeding. Animals have organs of apprehension by which they lay hold of their food; they search for pasture, and have a choice in their aliment. But plants are under the necessity of receiving such nourishment as the soil affords them, without exerting any choice in the species of their food, or in the manner of acquiring it: The moisture of the earth is the only source of their nourishment. However, if we attend to the organization and action of the roots and leaves, we shall soon be convinced, that these are the external organs by which vegetables are enabled to extract their food; that the roots turn aside from a vein of bad earth, or from any obstacle which they meet with, in search of a better soil; and that they split and separate their fibres in different directions, and

even

§ ANALOGIES BETWEEN

even change their form, in order to procure nourishment to the plant. A general distinction, therefore, between the animal and vegetable, cannot be founded on their manner of feeding.

From this investigation we are led to conclude, that there is no absolute and essential distinction between the animal and vegetable kingdoms; but that nature proceeds by imperceptible degrees from the most perfect to the most imperfect animal, and from that to the vegetable: Hence the fresh water polypus may be regarded as the last of animals, and the first of plants.

After examining the distinctions, we shall now inquire into the resemblances which take place between animals and vegetables. The power of reproduction is common to the two kingdoms, and is an analogy both universal and essential. This mutual faculty would induce us to think that animals and vegetables are beings of the same order.

A second resemblance may be derived from the expansion of their parts, which is likewise a common property; for vegetables grow as well as animals; and, though some difference in the manner of expansion may be remarked, it is neither general nor essential; since the growth of some considerable parts of animals, as the bones, the hairs, the nails, the horns, &c. is the effect of a genuine vegetation; and the foetus, in its first formation, may be rather said to vegetate than to live.

A third resemblance arises from the following fact: Some animals are propagated in the same manner and by the same means, as vegetables. The multiplication of the vine-fretter, (*puceron*), which is effected without copulation, is similar to that of plants by seed; and the multiplication of the polypus by cuttings resembles that of plants by slips.

We may, therefore, conclude, with more certainty, that animals and vegetables are beings of the same order, and that Nature passes from the one to the other by imperceptible degrees; since the properties in which they resemble each other are universal and essential, while those by which they are distinguished are limited and partial.

Let us next compare animals and vegetables in different points of view; for example, with regard to number, situation, magnitude, figure, &c. from which new inductions will arise.

Animals exceed plants in the number of species. In the class of insects alone, there are, perhaps, a greater number of species, than of the whole species of plants on the face of the earth. Animals differ from each other much more than plants: It is the great similarity of plants that has given rise to the difficulty of distinguishing and arranging them, and to the variety of botanical systems, which are much more numerous than those of zoology.

Beside

Beside being more strongly characterised, every species of animal is distinguishable from another by copulation. Those may be regarded as of the same species which, by copulation, uniformly produce and perpetuate beings every way similar to their parents; and those which, by the same means, either produce nothing, or dissimilar beings, may be considered as of different species. A fox, for example, will be of a different species from a dog, if nothing results from the intercourse of a male and a female of these two animals; or, if the result be a dissimilar creature, a kind of mule, as this mule cannot multiply, it will be a sufficient demonstration that the fox and dog are different species of animals. In plants, we have not the same advantage; for, though sexes have been attributed to them, and generic distinctions have been founded on the parts of fructification; yet, as these characteristics are neither so certain nor so apparent as in animals; and, as the reproduction of plants can be accomplished by several methods which have no dependence on sexes, or the parts of fructification, this opinion has not been universally received; and it is only by the misapplication of analogy, that the sexual system has been pretended to be sufficient to enable us to distinguish the different species of the vegetable kingdom.

Though the species of animals be more numerous than those of plants, the number of individuals

viduals in each species of the latter far exceed those of the former. In animals, as well as in plants, the number of individuals is much greater in the small than in the large kinds. Flies are infinitely more numerous than elephants; and there are more herbs than trees. But, if we compare the number of individuals in each species, the individuals in each species of plant far exceed those of the animal. Quadrupeds, for example, produce but few at a time, and at considerable intervals. Trees, on the contrary, produce annually an amazing number of seeds. It may be alledged, that, to render this comparison exact, the number of seeds produced by a tree should be compared with the number of germs contained in the semen of an animal; and then, perhaps, it would appear, that animals abound more in germs than vegetables. But, by collecting and sowing the seeds of a single elm tree, 100,000 young elms may be raised from the product of one year. Though a horse, however, were furnished with all the mares he could cover in a year, the result between the production of the animal and of the plant would be very different. I avoid taking notice of the number of germs; because of these, especially in the animal, we have no certain knowledge, and because the same seminal germs may exist in the vegetable; for the seed of a plant is not a germ, but a production as perfect as the foetus of an animal, and which,

which, like a foetus, requires only the expansion of its parts.

To this may be opposed the prodigious multiplication of some kinds of insects, as the bee, a single female of which will produce 30 or 40 thousand. But, it ought to be remarked, that I am here speaking in general of animals compared with vegetables. Besides, the bee, which affords, perhaps, an example of the greatest multiplication among animals, proves nothing against the present doctrine; for, out of 30 or 40 thousand flies produced by the mother-bee, there are but very few females, and no less than 1500 or 2000 males: The rest are of neither sex, and totally incapable of procreating.

It must be acknowledged, that some species of insects, fishes, and shell-animals, appear to be extremely prolific. Oysters, herrings, fleas, &c. are perhaps equally fertile as mosses, and the most common plants. But, in general, most species of animals are less prolific than plants; and, upon comparing the multiplication of the different species of plants, we find not such remarkable differences, with regard to number, as take place among animals. Some animals produce great numbers, and others very few. But, in every species of plants, the quantity produced is always great.

From what we have already observed, it appears, that, both in the animal and vegetable kingdoms, the smallest and most contemptible species

species are the most prolific. In proportion as animals seem to be more perfect, the number of individuals decreases. Does the production of particular forms of body, necessary for the perfecting of sentiment, as those of quadrupeds, and of birds, cost nature more expence of organic particles than the production of inferior creatures?

Let us now compare animals and vegetables with regard to situation, size, and figure. Vegetables can exist no where but on the earth. Most of them are attached to the soil by roots: Some, as truffles, are entirely covered with the soil; and a few grow under water. But the whole require a connection with the surface of the earth. Animals, on the contrary, are more generally diffused. Some inhabit the surface, and others the interior parts of the earth. Some never rise above the bottom of the ocean, and others swim in the waters. The air, the internal parts of plants, the bodies of men and of other animals, and even stones themselves, are stored with inhabitants.

By the assistance of the microscope, many new species of animals have been discovered. But, what is singular, we are not indebted to this instrument for above one or two species of plants. The small moss, of which mouldiness consists, is perhaps the only microscopic plant that has been described. From this it would appear, that Nature has refused existence to very small plants, while

while she has created animalecles in the greatest profusion. But this opinion should not be adopted without examination. Plants are so similar in their structure, that it is much more difficult to distinguish them than animals. This mouldiness, which we imagine to be only a very small moss, may be a forest or a garden consisting of a multitude of different plants, though we are unable to distinguish them.

Animals and vegetables differ also with regard to size. There is a greater disproportion between the bulk of a whale and that of one of these pretended microscopic animals, than between the largest oak and the small moss mentioned above. Though bulk be only a relative attribute, it may be useful to know the limits within which nature has confined her productions. As to largeness, plants differ but little from animals. The quantity of matter in a whale and in a large tree is nearly equal ; but, as to smallness, some men have pretended to have seen animals so extremely minute, that a million of them collected in a heap would not equal the small moss on a piece of mouldy bread.

The most general and most obvious distinction between plants and animals arises from their figure. The form of animals, though infinitely various, has no resemblance to that of plants : And, though the polypi, which, like plants, can be multiplied by cuttings, may be regarded as the link which connects the animal and vegetable

table kingdoms, not only from the manner of their reproduction, but still more from their figure ; yet there is no danger of mistaking the one for the other. The operations of some animals resemble plants or flowers. But plants never produce any thing similar to an animal ; and those wonderful insects which make corals, would never have been mistaken for flowers, if, by a foolish prejudice, coral had not been regarded as a plant. Thus the errors we may commit in comparing plants and animals, are confined to a few objects which lie on the extremities of the two kingdoms ; and the farther we extend our observations, we shall be the more convinced, that the Creator has instituted no fixed limits between the animal and vegetable ; that these two species of organized beings possess a greater number of common properties than of real differences ; that the production of an animal requires, perhaps, a smaller exertion of Nature than the production of a vegetable ; or rather, that the production of organized bodies requires no immediate exertion at all ; and, lastly, that animation, or the principle of life, instead of a metaphysical step in the scale of being, is a physical property common to all matter.

CHAPTER

C H A P T E R II.

Of Reproduction in general.

WE shall now examine more closely this property, which is common to the animal and vegetable, this faculty of producing beings similar to themselves, this successive chain of individuals which constitutes the real existence of the species: And, without limiting our research to the generation of man, or of any particular animal, let us contemplate the general phaenomena of reproduction; let us collect facts, and enumerate the various methods employed by Nature for the renovation and transmission of organized existences.

The first, and apparently the most simple method, is to assemble in one body an infinite number of similar organic bodies, and to compose its substance in such a manner, that every part shall contain a germ or embryo of the same species, and which might become a whole of the same kind with that of which it constitutes a part*.

This

* The intelligent reader will perceive that this sentence, though not very obvious, contains the principle upon which the subsequent theory of generation adopted by the author is founded. It means no more than that the bodies of animals and of vegetables are composed of an infinite number of organic particles, perfectly similar, both in figure and substance, to the whole animal or plant, of which they are the constituent parts.

This apparatus appears, at first sight, to suppose a profusion of expence. Such magnificence, however, is not uncommon in Nature. It is discernible even in the more common and inferior species, as in worms, polypi, elms, willows, and many other plants and insects, every part of which contains a whole, and, in order to become a plant or an insect, requires only to be unfolded or expanded. Considering organized bodies under this point of view, an individual is a whole uniformly constructed in all parts, a collection of an infinite number of particles every way similar, an assemblage of germs or minute individuals of the same species, which, in certain circumstances, are capable of being expanded, and of becoming new beings like those from which they were originally separated.

This idea, when traced to the bottom, discovers a relation between animals, vegetables, and minerals, which we would not have suspected. Salts, and some other minerals, consist of parts similar to one another, and to the whole. A grain of sea-salt, as we distinctly perceive by the microscope, is a cube composed of an infinite number of smaller cubes *, which, as we disco-

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* Hac tam parvae quam magnae figurae (saliūm) ex magno solum numero minorum particularum, quae eandem figuram habent, sunt conflatæ, sicuti mihi saepe licuit observare, cum aquam marinam aut communem in qua sal commune liquatum erat, intucor per microscopium, quod ex ea prodeunt elegantes, parvae, ac quadrangulares figuræ adeo exiguae, ut mille earum myriades

ver by a larger magnifier, are themselves composed of still smaller cubes. The primitive and constituent particles of this salt must, therefore, unquestionably consist of cubes so minute, that they will for ever escape our observation. Plants and animals, which possess the power of multiplying by all their parts, are organized bodies composed of similar organic bodies, the primitive and constituent particles of which are also organic and similar. Of these we discern the accumulated quantity ; but we can only recognise the constituent particles by reason and analogy.

From this view, we are led to conclude, that there exists in nature an infinity of *organic, living particles* *, of the same substance with organized beings. A similar structure we have already remarked in more inanimate matter, which is composed of an infinite number of minute particles that have an exact resemblance to the whole body. And, as the accumulation perhaps of millions of cubes are necessary to the formation

myriades magnitudinem arenæ crassioris ne aequent. Quæ salis minutæ particulae, quam primum oculis conspicio, magnitudine ab omnibus lateribus cœfcent, siuam tamen elegantem superficiem quadrangularem retinentes, fere Figurae hæ salinae cavitæ donatae sunt, &c. ; See Leeuwenhook, Arc. Nat. tom. I. p. 3.

* To avoid the introduction of terms which might not be generally understood, it is necessary to inform the reader, that the phrases *corps organiques vivans*, *parties organiques vivantes*, et *moleculæ organiques vivantes*, which occur so often in this volume, and form the basis of our author's theory, are uniformly, in the version, expressed by the words *organic particles*.

formation of a single grain of sea-salt that is perceptible by our senses, an equal number of similar organic particles are requisite to produce one of those numberless germs contained in an elm, or in a polypus. A cube of sea-salt must be dissolved before we can discover, by means of crystallization, the minute cubes of which it is composed: In the same manner, the parts of an elm or of a polypus must be separated, before we can recognise, by means of vegetation, or expansion, the small elms or polypi contained in the different parts of these bodies.

The difficulty of assenting to this idea proceeds from the well known prejudice, that we can only judge of the compound by the simple; that, to discover the organic structure of any being, it must first be reduced to its simple and unorganic parts; and that hence it is more easy to conceive how a cube must necessarily be composed of other cubes, than how a polypus can be composed of other polypi. But, if we examine attentively what is meant by simple and compound, we shall find, that in this, as in every thing else, the plan of Nature is very different from the grossness and imperfection of our conceptions.

Our senses, it is well known, convey not to us exact representations of external objects. When we want to calculate, to judge, to compare, to weigh, to measure, &c. we are obliged to have recourse to foreign aid, to rules, to prin-

ciples, to usages, to instruments, &c. All these miniciles are efforts of human genius, and belong more or less to the abstraction of our ideas. This abstraction, with regard to us, constitutes the simplicity of things ; and the difficulty of reducing them to this abstraction is the compound. Extension, for example, being a general and abstract property of matter, is not much compounded. In order, however, to judge concerning it, we have imagined some extensions to have no thickness, others to have neither thickness nor breadth, and points, which are extensions without being extended. All these abstractions have been invented as supports to the understanding ; and the few definitions employed in geometry have given rise to numberless prejudices and false conceptions. Whatever is reducible under any of these definitions is called simple ; and such things as cannot be easily reduced to this standard are considered as complex. Thus, a triangle, a square, a circle, a cube, and also those curves of which we know the geometrical properties, are regarded as simple. But every thing which we cannot reduce under these figures, or abstract rules, appears to us to be complex. We never reflect, that all these geometrical figures exist no where but in our own imaginations, or that, if they are ever found in Nature, it is only because she exhibits every possible form ; and the appearance of simple figures, as an exact cube, or an equilateral pyramid, is, perhaps,

perhaps, more difficult and rare to be found in Nature, than the complex forms of plants or of animals. It is in this manner that we perpetually consider the abstract as simple, and the real as complex. But, in nature, no abstract exists; nothing is simple; every object is compounded. We are unable to penetrate into the intimate structure of bodies. We cannot, therefore, determine what objects are more or less complex, unless by the greater or less relation they have to ourselves, and to the rest of the universe. For this reason we regard the animal as being more complex than the vegetable, and the vegetable than the mineral. With respect to us, this notion is just; but we know not whether the animal, vegetable, or mineral, be, in reality, the most complex or the most simple; and we are ignorant whether the production of a globe or a cube requires a greater effort of Nature than that of a germ, or an organic particle. If we were to indulge in conjectures upon this subject, we might imagine that the most common and numerous objects are the most simple. But this would make animals more simple than plants or minerals; because the former exceed the latter in number of species.

But, without dwelling longer on this subject, it is sufficient to have shown, that all our notions concerning simple and compound are abstract ideas; that they cannot be applied to the complex operations of nature; that, when we

attempt to reduce all bodies into elements of a cubical, prismatic, globular, or any other regular figure, we substitute our own imaginations in opposition to real existences ; and that the forms of the constituent particles of different bodies are absolutely unknown to us ; and, of course, we may believe or suppose that organized beings are composed of similar organic particles, as well as that a cube consists of other cubes. We have no other method of judging but by experience. We know that a cube of sea-salt is composed of many lesser cubes, and that an elm consists of a great number of minute elms ; because if we take a piece of a branch, of a root, of the wood separated from the trunk, or a seed, from all these a new tree is produced. The polypus, and some other species of animals, may likewise be multiplied by cuttings separated from any part of their bodies ; and, as our rule of judging in both cases is the same, why should we form a different opinion concerning them ?

The above reasoning renders it extremely probable, that there really exists in Nature an infinite number of small organized beings, every way similar to those large organized bodies which make such a conspicuous figure in this world ; that these small organized beings are composed of living organic particles, which are common both to animals and vegetables, and are their primary and incorruptible elements ; that an assemblage of these particles constitutes an animal

animal or a plant; and, consequently, that reproduction or generation is nothing but a change of form, effected solely by the addition of similar particles; and the death, or resolution of organized bodies, is only a separation of the same particles. Of the truth of this doctrine, not a doubt will remain, after the proofs delivered in the following chapters are perused. Besides, if we reflect on the growth of trees, and consider what an immense mass is produced from so small an origin, we must be persuaded that this increase of matter is effected by the simple addition of organic particles which are similar to one another and to the whole. The seed first produces a small tree, which it contained in miniature within its coats. At the top of this small tree a bud is formed, which contains the tree that is to spring the next season; and this bud is an organized body similar to the small tree of the preceding year. The small tree of the second year, in the same manner, produces a bud which contains a tree for the third year; and this process uniformly goes on as long as the tree continues to vegetate: Buds are likewise formed at the extremity of each branch, which contain, in miniature, trees similar to that of the first year. It is evident, therefore, that trees are composed of minute organized bodies similar to themselves, and that the whole individual is formed by a numerous assemblage of minute and similar individuals.

But,

But, it may be demanded, were not all these minute, and similarly organized bodies, contained in the seed? and may not the order of their unfolding be traced from that source? for it is apparent, that the first bud was surmounted by a similar bud, which was not expanded till the second year, and the third bud was not unfolded till the third year; and, consequently, the seed may be said to have really contained the whole buds which would be formed for 100 years, or till the dissolution of the plant: It is also apparent, that this seed contained not only all the small organized bodies which must in time have constituted the individual tree itself, but likewise all the seeds, and all the individuals which would successively arise, till the final destruction of the species.

This, indeed, is a capital difficulty: We shall therefore examine it with the greater attention. It is true, that the seed produced a small tree the first year, solely by the unfolding of the bud or germ which it contained, and that this small tree existed in miniature in the bud. But it is not equally certain that the bud of the second year, and those of the succeeding years, nor that all the small organic bodies, and the seeds which must have been formed till the end of the world, or the destruction of the species, were contained in the first seed. This opinion supposes an infinite progression, and makes every individual a source of eternal generations. The first

first seed, for instance, must have included all the plants of its species which have existed, or ever will exist; and the first man must have contained in his loins all the men who have appeared, or ever will appear, on the face of the earth. Every seed, and every animal, according to this doctrine, must have included in its own body an infinite posterity. If we yield to reasonings of this kind, we must lose sight of truth in the labyrinths of infinity; and, in place of solving, or of throwing light upon the question, we will involve it in tenfold obscurity. It is removing the object beyond the reach of our vision, and then complaining that it cannot be seen.

Let us investigate the nature of the ideas of infinite progression and expansion. How do we acquire them? In what do they instruct us? We derive the idea of infinity from the idea of what is limited. It is in this manner we obtain the ideas of infinite succession, and geometrical infinity: Every individual is a unit; several individuals make a limited number; and a whole species is to us an infinite multitude. From the same data by which we have demonstrated the nonentity of geometrical infinity, we might prove, that infinite succession, or propagation, rests on no firmer basis; that it is only an abstract idea, a mere deduction from the idea of finite objects, by lopping off the limits which necessarily terminate every magnitude *; and, of course, that

every

* See this fully demonstrated in my preface to the French translation of Newton's fluxions, p. 7.

every opinion which infallibly leads to the idea of actual existence, upon no better authority than what is derived from geometrical or numerical infinity, ought to be rejected.

The partizans of this opinion are now reduced to the necessity of acknowledging, that their infinity of succession and of multiplication is only an indeterminable or indefinite number. But, say they, the first seed, of an elm, for example, which weighs not a grain, actually contains all the organic particles requisite for the formation of this tree, and of all the individuals of the same species which shall ever appear. Is this a solution of the difficulty? Is it not cutting the knot, in place of untying it?

When, in reply to the question, how beings are multiplied? it is answered, that the multiplication was completed in the creation of the first individuals, is not this both an acknowledgment of ignorance, and a renouncing of all desire of farther improvement? We ask how one being produces its like? and we receive for answer, that the whole was created at once. A strange solution; for, whether one only or a thousand generations had passed, the same difficulty remains, and, instead of removing it, the supposition of an indefinite number of germs, all existing and contained in a single germ, increases and renders it altogether incomprehensible.

I allow, that it is much easier to find fault, than to investigate truth, and that the question concerning

concerning reproduction is perhaps of such a subtile nature, as not to admit of a full and satisfactory explication. But we ought at least to inquire whether it be altogether inscrutable; and, in the course of this inquiry, we will discover all that can be known, and the reason why we can know no more.

Questions or inquiries are of two kinds; the first regard primary causes, the other particular effects. If, for example, it be asked why matter is impenetrable? we must either return no answer, or reply by saying, that matter is impenetrable, because it is impenetrable. The same answer must be made, if we inquire into the cause of gravity, of extension, of the inertia of bodies, or of any general quality of matter. Such is the nature of all general and abstract qualities, that, having no mode of comparing them with other objects in which they do not exist, we are totally incapable of reasoning concerning them; and therefore all inquiries of this kind, as they exceed the powers of human intellect, are perfectly useless.

But, on the other hand, if the reason of particular effects be demanded, we are always in a condition to give a distinct answer, whenever we can show that these effects are produced by one of the general causes; and the question is equally solved, whether the particular effect proceeds immediately from a general cause, or from a

chain

chain of successive effects, provided we have a clear conception of the dependence of these effects upon each other, and of their mutual relations.

But, when a particular effect appears not to have any dependence upon more general effects, or has no analogy to those already known, we are then totally unable to give any explication of such effect; because we have no similar object with which it can be compared. We cannot explain a general cause, because it equally exists in every object; and, on the contrary, we can give no account of a single or isolated effect; because the same quality exists not in any other subject. To explain a general cause, we must discover one still more general; but a single and detached effect may be illustrated by the discovery of an analogous effect, which experience or accident may exhibit.

There is still another kind of question, which may be called a question of fact. For example, why do trees, dogs, &c. exist? All questions of this kind are perfectly insolvable; for those who solve them by final causes consider not that they mistake the effect for the cause: The relation of particular objects to ourselves has no connection with their origin. Moral affinity or fitness can never become a physical reason.

Questions in which we employ the word *Why*, ought to be carefully distinguished from those in

in which we employ *How*, and still more from those in which we ought to use the words *how much* or *how many*. *Why* always relates to the cause of the effect, or to the effect itself; *how* relates to the manner in which the effect happens; and *how much* relates to the measure or quantity of the effect.

These distinctions being established, let us now examine the question concerning the reproduction of beings. If it be demanded *why* animals and vegetables continue their species? we clearly perceive that this is a question of fact, and therefore it is useless and insolvable. But, if it be asked *how* animals and vegetables are reproduced? we are enabled to solve the question, by giving the history of the generation of every species of animal, and of the reproduction of every species of plant: After tracing, however, every possible method of propagation, and making the most exact observations, we have learned the facts only, but have not discovered the causes: And, as the means Nature employs in multiplying and containing the species, seem to have no relation to the effects produced, we are still under the necessity of asking, by what secret cause she enables beings to propagate their kinds?

This question is very different from the first and second. It admits of nice scrutiny, and even allows us to employ the powers of imagination. It is, therefore, by no means insolvable; for

for it belongs not to a general cause. Neither is it solely a question of fact: And if we can conceive a method of reproduction, depending on primary causes, or which, at least, is not repugnant to them, we ought to be satisfied with it; and the more relation it has to the other effects of Nature, it will rest upon a firmer basis.

By the nature of the question, then, we are permitted to form hypotheses, and to choose that which appears to have the greatest analogy to the other phaenomena of nature. But we ought to reject every hypothesis which supposes the thing to be already accomplished; such, for example, as that which supposes the first germ to contain all the germs of the same species, or that every reproduction is a new creation, an immediate effect of the will of the Deity; for all hypotheses of this kind are mere matters of fact, concerning which it is impossible to reason. We must likewise reject every hypothesis which is founded on final causes, such as, that reproduction is ordained in order to replace the living for the dead; that the earth may always be covered with vegetables and peopled with animals; that men may be supplied with abundance of nourishment, &c.; for such hypotheses, in place of explaining the effect by physical causes, stand on no other foundation than arbitrary relations and moral affinities. We ought, at the same time, to despise those general axioms and physical problems so frequently and so injudiciously

ly employed as principles by some philosophers, such as, ‘ Nulla foecundatio extra corpus ;’ every living creature proceeds from an egg ; generation always supposes sexes, &c. These maxims must not be taken in an absolute sense ; they signify no more than that the thing happens more commonly in this manner than in any other.

Let us then endeavour to find an hypothesis that will be liable to none of these defects or incumbrances ; and, if we shall not succeed in explaining the mechanism employed by Nature for the reproduction of beings, we shall, at least, be able to approach nearer to the truth than we have hitherto reached.

In the same manner as we make moulds by which we can bestow on the external parts of bodies whatever figure we please, let us suppose, that Nature can form moulds by which she bestows on bodies both an external and internal figure ; would not this be one method by which reproduction might be effected ?

Let us first consider whether this supposition be well founded ; let us examine whether it contains any thing that is absurd or contradictory ; and then we shall discover what consequences may be drawn from it. Though our senses reach not beyond the external parts of bodies, we have clear ideas of their different figures and external affections, and we can imitate Nature, by representing external figures in different

different ways, as by painting, by sculpture, and by moulds. But, though our senses be limited to external qualities, we know that bodies possess internal qualities, some of which are general, as gravity. This quality or power acts not in proportion to the surfaces, but to the masses, or the quantities of matter. Thus there are in Nature powers, and even of the most active kind, which penetrate the internal parts of matter. We are unable to form distinct ideas of such qualities; because, not being external, they fall not under the cognisance of our senses. But we can compare their effects, and may draw analogies from them, in order to account for the effects of similar qualities.

If our eyes, instead of representing to us the surfaces of bodies only, were so constructed as to perceive their internal parts alone, we should then have clear ideas of the latter, without knowing any thing of the former. Upon this supposition, moulds for the internal constitution, which I have supposed to be employed by Nature, would be equally obvious and easy to conceive as moulds for the external figures of bodies; and we should then be in a condition to imitate the internal parts of bodies, as we now imitate the external. These internal moulds, though beyond our reach, may be in the possession of Nature, as she endows bodies with gravity, which penetrates every particle of matter. The supposition of internal moulds being thus

thus founded on analogy, let us next examine whether it involves any contradiction.

It may be alledged, that the expression, *internal mould*, includes two opposite and contradictory ideas; for the idea of a *mould* relates only to the surface; but the idea of internal, as here employed, has a relation to the whole mass; and therefore we might, with equal propriety, talk of a massy surface as of an internal mould.

I allow, that, when ideas are attempted to be represented which have never been expressed, we are sometimes obliged to use terms that are apparently contradictory. To avoid this inconvenience, philosophers have been accustomed to employ unusual terms, instead of those which have a received signification. But this artifice is of no use, when we can show, that the seeming contradiction lies in the words, and not in the idea. A simple idea, however, cannot include a contradiction; *i. e.* whenever we can form an idea of a thing, if this idea be simple, it cannot be complex; it can include no other idea; and, of course, it can contain nothing that is opposite or contradictory.

Simple ideas are not only the first apprehensions received by the senses, but the first comparisons which we form of these apprehensions: For the first apprehension is always the result of comparison. The idea of the largeness or distance of an object necessarily implies a comparison with bulk or distance in general. Thus,

when an idea includes nothing more than comparison, it ought to be regarded as simple; and, consequently, it can contain nothing contradictory. The idea of an internal mould is of this species. There is in nature a quality known by the name of gravity, which penetrates the internal parts of bodies. I understand the idea of an internal mould to be relative to gravity; and, therefore, as it includes only a comparison, it can imply no contradiction.

Let us now trace the consequences which may be drawn from this supposition; let us likewise investigate such facts as may correspond with it; and the more analogies we can collect, the supposition will be rendered the more probable. We shall begin with unfolding the idea of internal moulds; and then explain how it may lead us to conceive the mode of reproduction.

Nature, in general, appears to have a greater bias towards life than death: She seems anxious to organize bodies as much as possible. Of this the multiplication of germs, which may be infinitely increased, is a convincing proof; and it may be safely affirmed, that, if all matter is not organized, it is only because organized beings destroy one another; for we can increase at pleasure the number of animals and vegetables; but we cannot augment the quantity of stones or of dead matter; which seems to indicate, that the most ordinary and familiar operation of Nature

ture is the production of organized bodies ; and here her power knows no limitation.

To render this idea more plain, we shall calculate what may be produced by a single germ. The seed of an elm, which weighs not above the hundredth part of an ounce, will, in 100 years, form a tree, of which the mass will amount to ten cubic fathoms. But, at the tenth year, this elm will have produced 1000 seeds, each of which, in 100 years more, will consist of ten cubic fathoms. Thus, in the space of 110 years, more than 10,000 cubic fathoms of organized matter are produced. Ten years after, we shall have ten million of fathoms, without including the annual increase of 10,000 which would amount to 100,000 more ; and in ten years more, the number of cubick fathoms would be 10,000,000,000,000. Hence, in 130 years, a single germ would produce a mass of organized matter equal to 1000 cubic leagues ; for a cubic league contains only about 10,000,000,000 cubic fathoms. Ten years after, this mass would be increased to a thousand times a thousand leagues, or one million of cubic leagues ; and in ten more it would amount to 1,000,000,000,000 cubic leagues ; so that, in the space of 150 years, the whole globe might be converted into organized matter of a single species. Nature would know no bounds in the production of organized bodies, if her progress were not obstructed by matter

which is not susceptible of organization; and this is a full demonstration that she has no tendency to increase brute matter; that her sole object is the multiplication of organized beings; and that, in this operation, she never stops but when irresistible obstacles occur. What we have remarked concerning the seed of an elm may be extended to any other germ; and it would be easy to show, that, by hatching all the eggs which are produced by hens for a course of 30 years, the number of fowls would be so great as to cover the whole surface of the earth.

Calculations of this kind evince the tendency of Nature towards the production of organized bodies, and the facility with which she performs the operation. But I will not stop here. Instead of dividing matter into *organized* and *brute matter*, the general division ought to be into *living* and *dead matter*. That *brute matter* is nothing but matter produced by the *death* of animals and vegetables, might be proven from the enormous quantities of shells, and other relicks of living bodies, which constitute the principal parts of stones, marbles, clays, marls, earths, turfs, and other substances that are commonly reckoned *brute matter*, but are, in reality, composed of decayed animals and vegetables. This doctrine will be farther illustrated by the subsequent remarks, which appear to be well founded.

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The great facility and activity of Nature in the production of organized bodies, the existence of infinite numbers of organic particles which constitute life, have been already shown. We now proceed to inquire into the principal causes of death and destruction. In general, beings which have a power of converting matter into their own substances, or of assimilating the parts of other beings, are the greatest destroyers. Fire, for example, which converts almost every species of matter into its own substance, is the greatest source of destruction that we are acquainted with. Animals seem to partake of the nature of flame ; their internal heat is a species of fire approaching to flame. Accordingly, animals are the greatest destroyers ; and they assimilate and convert into their own substance all bodies which can serve them for nourishment. But, though these two causes of destruction be considerable, and their effects tend perpetually to the destruction of organized bodies, the cause of reproduction is infinitely more active and powerful. It even seems to derive, from destruction itself, fresh powers of multiplying ; for assimilation, which is one cause of death, is, at the same time, a necessary mean of producing life.

The destruction of organized bodies, as has been remarked, is only a separation of the organic particles of which they are composed. These particles continue separate till they be again united

nited by some active power. But what is this power? It is the power, possessed by animals and vegetables, of assimilating the matter of their food; and is not this the same, or nearly connected with the same power which is the cause of reproduction?

C H A P.

C H A P. III.

Of Nutrition and Growth.

A N animal body is a kind of internal mould, in which the nutritive matter is so assimilated to the whole, that, without changing the order or proportion of the parts, each part receives an augmentation. This increase of bulk has, by some philosophers, been called an expansion or unfolding of the parts; because they fancied they had accounted for the phenomenon, by telling us, that the form of an animal in embryo was the same as at full maturity, and that, therefore, it was easy to conceive how its parts should be proportionally unfolded and augmented by the addition of accessory matter.

But, how can we have a clear idea of this augmentation or expansion, if we consider not the bodies of animals, and each of their parts, as so many internal moulds which receive the accessory matter in the order that results from their position and structure? This expansion cannot be effected solely by an addition to the surfaces, but, on the contrary, by an intus-susception, or by penetrating the whole mass; for the size of

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the part is augmented proportionally, without changing its form. Hence it is necessary, that the increasing matter must, in some manner or other, intimately penetrate the whole part in all its dimensions: It is equally necessary, that this penetration should be effected in a fixed order and proportion, so that no internal point receive more matter than another; otherwise some parts would be more quickly unfolded than others, which would entirely change their figure. What can thus regulate the accessory matter, and force it to arrive equally and proportionally to every internal point of the body, if we have not recourse to an internal mould?

The bodies of animals and of vegetables, therefore, consist of internal moulds, which uniformly preserve the same figure. But their masses may receive a proportional increase, by the expansion of the moulds in all their dimensions, both internal and external; and this expansion is effected by an intus-susception of an accessory and foreign matter, which intimately penetrates the whole, and assumes the same form and identity of substance with the matter of the moulds themselves.

But what is the nature of that matter which an animal, or a vegetable, assimilates to its own substance? What bestows on it that force and activity which enables it to penetrate the internal mould? If such a power exists, must it not

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be similar to that by which the mould itself is capable of being reproduced?

These three questions include the whole subject, and appear to depend on one another; for it is impossible to explain, in a satisfactory manner, the reproduction of animals or vegetables, if we have not a clear idea how the operation of nutrition is performed. Each question, therefore, demands a separate examination, that we may be enabled to compare their results.

The first, which regards the nature and qualities of the nutritive matter, is in part resolved by the preceding reasonings, and shall be clearly unfolded in the subsequent chapters. We shall show, that there are in Nature infinite numbers of living organic particles; that Nature produces them without any expence, because their existence is constant and invariable; that the causes of death disunite these particles only, but do not destroy them. Thus the matter assimilated by an animal or vegetable, is an organic matter of the same nature with that of the animal or vegetable, and, consequently, may augment the size without changing the figure or the qualities of the original moulds; because it has the same qualities and the same form with the matter of which the moulds themselves are composed. Of the quantity of aliment taken by an animal to support its life, and to maintain the vigour of its organs, and of the juices absorbed by the roots and leaves of a plant, a great

part

part is rejected by transpiration, by secretions, and by other excretaries ; and a small portion only is retained for the nourishment and expansion of the parts. It is extremely probable, that, in the bodies of animals and of vegetables, a separation is made between the *brute* particles of the aliment and the organic ; that the former are carried off by the methods just mentioned ; that nothing but the organic particles remain ; and that they are distributed, by means of some active power, to the different parts, in a proportion so exact, that neither more nor fewer are applied than answer the purposes of nutrition, and of an equal growth and expansion.

As to the second question, What is the nature of that active power, which enables the organic matter to penetrate and combine with the internal mould ? It is apparent, from the preceding chapter, that powers exist in Nature, like that of gravity, which affect the most internal parts of matter, without having the smallest relation to its external qualities. These powers, as formerly observed, are beyond the reach of our senses ; because their action is exerted upon the intimate structure of bodies. It is evident, therefore, that we can never obtain a clear idea of them, nor of their mode of acting. Their existence, however, is not less certain, than that, by means of them, most natural effects are produced, especially those of nutrition and expansion, which must be owing to a cause that penetrates the

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most intimate recesses of the original moulds ; for, in the same manner as gravity pervades the whole parts of matter, the power which pushes forward or attracts the organic particles of food, penetrates the internal parts of organized bodies ; and, as these bodies have a certain form, which we have distinguished by the appellation of *internal moulds*, the organic particles, pushed on by the action of this penetrating force, must enter in an order relative to this form, and consequently cannot alter its figure, but only augment its bulk, and give rise to the growth and expansion of organized bodies : And if, in the organized body, thus expanded, there be some particles similar to the whole, both internally and externally, these parts will become the source of reproduction.

Let us now examine the third question, namely, Is it not by a similar power that the internal mould itself is reproduced ? This power appears to be not only similar, but the very same with that which is the cause of expansion and reproduction ; for, in an organized and expanded body, nothing farther is necessary for the reproduction of a new body similar to itself, than that it should contain some particle every way similar to the whole. This particle, at its first separation, will not present to our eyes a sensible figure by which we can compare it with the whole body. But, when separated from the body, and put in a situation to receive proper nourishment, this similar

lar particle will begin to expand and to exhibit the form of an entire and independent being, of the same species with that from which it was detached. Thus, a willow or a polypus, as they contain a larger proportion of particles similar to the whole, than most other substances, when cut into any indefinite number of pieces, each segment becomes a new body similar to the parent from which it was separated.

Now, in a body of which all the particles are similar to itself, the organization is the most simple, as has been remarked in the first chapter; for it is only a repetition of the same form, a congeries of figures, similarly organized. It is for this reason that the most simple bodies, the most imperfect species, are most easily and most abundantly reproduced. But, if an organized body contain only few particles similar to itself, as these alone are capable of a second expansion, its power of reproducing will be both more difficult, and more circumscribed as to the number produced. The organization of bodies of this last kind is also more complex, because it possesses fewer parts which are similar to the whole; and, therefore, the more perfectly a body is organized, its power of reproduction will be proportionally diminished.

In this manner we discover nourishment, growth, and propagation, to be effects of the same cause. Organized bodies are nourished by the particles of aliment which are similar to them; they

they grow or are expended by absorbing those organic particles which correspond to their own nature; and they propagate, because they contain some organic particles similar to themselves. It only remains to examine whether these similar organic particles are extracted from the food, or have a primary and independent existence in the bodies themselves. If we suppose the latter, we recur to the infinity of similar parts or germs contained within each other, an hypothesis which we have already shown to be replete with difficulties and absurdities. We must, therefore, maintain, that the similar parts are extracted from the food; and, after what has been said on the subject, we hope to be able to explain the manner of their absorption, and how the more minute organic particles which compose them are united.

We formerly remarked, that the organic parts of food were separated from those which have no analogy to the animal or vegetable, by transpiration and other excretions. The first remain, and serve to expand and nourish the body: But these organic parts must be of very different species; and, as each part of the body receives only a proper number of those which correspond to it, the surplus, it is natural to imagine, will be returned from all parts of the body, and be collected in one or more reservoirs, where they will unite and form small organic bodies similar to the first, and which require nothing but pro-

per circumstances for expanding and becoming new individuals of the same species; for, as all parts of the body send off organic particles similar to those of which themselves are composed, the result of their union must be the production of new organized bodies similar to the original. Hence we may conclude, that this is the reason why organized bodies, during the time of their growth and expansion, are seldom or never capable of reproducing; because the growing parts absorb the whole organic particles presented to them, and no surplus being sent from the different parts of the body, propagation becomes, of course, impracticable.

This account of nutrition, and of reproduction, will not, perhaps, be received by those philosophers who admit only a certain number of mechanical principles, and reject every thing as false which depends not upon them; and, as the explication now given of nutrition and reproduction has no connection with any of these principles, they will conclude that it deserves no credit. But I think very differently from these philosophers. In admitting only a few mechanical principles, they consider not how much they contract the bounds of philosophy, and how few phaenomena can, by this narrow method of thinking, be fully explored.

The notion of explaining all the appearances in Nature upon the principles of mechanism, is, doubtless, a great exertion, and was first attempted

ed by Des Cartes. But it is, at least, an untenable project; and, though it were otherwise, we are unable to put it in execution. These mechanical principles are, the extension of matter, its impenetrability, its motion, its external figure, its divisibility, the communication of motion by impulse, by the action of springs, &c. These ideas we have acquired by our senses, and we regard them as principles, because they are general and common to all matter. But are we certain that matter possesses no other qualities? Ought we not rather to believe that these qualities, which we assume for principles, are only modes of perception; and that, if the conformation of our senses were different, we would recognize qualities in matter very different from those above enumerated? It is presumptuous to deny every quality to matter but those we are acquainted with. Many general qualities, perhaps, remain to be discovered; and many may exist which will for ever elude human discernment. The cause of impulsion, of cohesion, or of any other mechanical principle, will always continue to be equally inscrutable as that of attraction, or of any other general quality. Hence it may be concluded, that mechanical principles are nothing else than general effects which experience has enabled us to remark in matter; and that, whenever we shall discover, either by reflection, by analogy, or by experience, a new general effect, it will become a new mechanical principle,

principle, which may be employed with equal advantage and certainty as any of those that are already known.

The defect of Aristotle's philosophy was the employing particular effects as causes; and that of Des Cartes consists in the rejection of every cause, but a few general effects. To use nothing as causes but general effects, to endeavour to augment the number of these, and to attempt to generalize particular effects, would constitute the most perfect principles of genuine philosophy.

In my theory of expansion and reproduction, I first admit the mechanical principles, then the penetrating force of gravity, and, from analogy and experience, I have concluded the existence of other penetrating forces peculiar to organized bodies. I have proved by facts, that matter has a strong tendency towards organization; and that there are in Nature an infinite number of organic particles. I have, therefore, only generalized particular observations, without advancing any thing contrary to mechanical principles, when that term is used in its proper sense, as denoting the general effects of Nature.

C H A P. IV.

Of the Generation of Animals.

AS the organization of man, and of other animals, is the most perfect, and the most complex, the propagation of them is likewise most difficult, and the number of individuals is less abundant. I except here such animals as can be multiplied by a separation of their parts, or without the aid of generation, these having been sufficiently treated of in the preceding chapter*.

But how will the theory delivered in the former chapter apply to the generation of men, and other animals, who are distinguished by sexes? We understand, from what has been said, how every individual may reproduce; but we cannot conceive how two individuals, the one a male, and the other a female, should uniformly produce a third.

Before replying to this objection, I must observe, that the writers on this subject have confined their ideas solely to the generation of men and of animals, without attending to the nature

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* Here the Author gives an unnecessary recapitulation of Chap. III. to which the reader is referred.

of reproduction in general: And as the generation of animals is the most complicated species of reproduction, they have laboured under great disadvantages, not only by attacking the most difficult point, but by leaving themselves no subject of comparison to enable them to illustrate the question. To this circumstance I chiefly attribute the unsuccessfulness of their attempts. But, by the method I have observed, I am persuaded that I shall be able to give a satisfactory explanation of every species of reproduction.

Let the generation of man serve as an example. To begin with infancy:

The expansion and growth of the different parts of man's body being effected by the intimate penetration of organic particles, analogous to each of these parts, all the organic particles, in early life, are absorbed, and entirely employed in unfolding and augmenting his different members. He has, of course, little or no superfluous particles, till his growth be completed. It is for this reason that infants are incapable of propagating. But, when man's body has nearly attained its full size, he requires not the same quantity of organic particles; the surplus is, therefore, sent from all parts into reservoirs destined for their reception. These reservoirs are the testes and seminal vessels. At this very period, when the growth of the body is nearly finished, puberty commences, and every phenomenon attending it discovers a superabundance

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of nourishment: The voice changes into a deeper tone; the beard begins to appear, and other parts of the body are covered with hair; the parts destined for generation are suddenly expanded; the seminal fluid fills the reservoirs prepared for its reception, and spontaneously escapes from the body during sleep. This superabundance is still more evident in the female: It discovers itself by a periodic evacuation, which begins and terminates with the faculty of propagating; by a quick increase of the breasts; and by a change in the sexual parts, which shall be afterwards explained *.

I conceive, then, that the organic particles sent from all parts of the body into the testicles and seminal vessels of the male, and into the ovary of the female, compose the seminal fluid which, in either sex, as formerly observed, is a kind of extract from the several parts of the body. These organic particles, instead of uniting and forming an individual similar to that in whose body they are contained, as happens in vegetables, and some imperfect animals, cannot accomplish this end without a mixture of the fluids of both sexes. When this mixture is made, if the organic particles of the male exceed those of the female, the result is a male; and if those of the female abound most, a female is generated. I mean not that the organic particles of the male or of the female could singly produce

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individuals;

* See below the Nat. Hist. of Man, chap. 2.

individuals: A concurrence or union of both is requisite to accomplish this end. Those small moving bodies, called *spermatic animals*, which, by the assistance of the microscope, are seen in the seminal fluids of all male animals, are, perhaps, organized substances proceeding from the individual which contains them; but, of themselves, they are incapable of expansion, or of becoming animals similar to those in whom they exist. We shall afterwards demonstrate, that there are similar animalecules in the seminal fluids of females, and point out the place where this fluid is to be found.

It is probable, that these organic bodies are only the first rudiments of an animal, containing nothing but its essential parts. We shall not enter into a detail of proofs on this subject, but content ourselves with remarking, that the organization of these pretended spermatic animals may be very imperfect; or rather, that they are the living organic particles mentioned above, which are common both to vegetables and to animals; or, at most, that they are only the first junction of these particles.

But, to return to our subject. It may be asked, how is it possible that the superfluous organic particles should be detached from all parts of the body, and unite upon the mixture of the male and female fluids? Besides, are we certain that such a mixture takes place? Has it not been maintained, that the female furnishes no fluid of the

this kind ? Is it an established fact, that the male fluid enters the uterus ? &c.

To the first question I reply, that, if what I had said concerning the penetration of the internal mould by the organic particles, in growth and nutrition, had been properly understood, it would be easy to conceive, that, when these particles are unable to penetrate the parts into which they formerly entered, they must take another route, and, of course, arrive at some other part, as the testicles and seminal vessels. Every attempt to explain the animal economy, and the various motions of the human body, by mechanical principles alone, must be vain and ineffectual ; for it is evident, that the circulation of the blood, muscular motion, and other functions of an animated body, cannot be accounted for by impulsion, or by any of the common laws of mechanism. It is equally evident, that growth and reproduction are effects of laws of a different nature. Why, then, do we refuse the existence of penetrating forces which act upon the whole substances of bodies, when we have examples of such powers in gravity, in magnetic attraction, in chemical affinities ? Since, therefore, we are assured by facts, and by a number of constant and uniform observations, that there are powers in nature which act not by impulsion, why are not these powers ranked among mechanical principles ? Why do we reject them in the explanation of effects

which they are known to produce? Why are we desirous of employing the power of compulsion only? Is not this equally absurd as to judge of painting by the touch; to explain the phaenomena which belong to the mass by those that relate only to the surface; or to use one sense in place of another? It is limiting the reasoning faculty to a small number of mechanical principles, which are by no means sufficient to explain the various effects of Nature.

But, if these penetrating forces be admitted, is it not natural to imagine, that those particles which are most analogous to one another will unite in the most intimate manner; that each part of the body will appropriate those which are most agreeable to its nature; and that the whole superfluous particles will form a seminal fluid, which shall contain all the organic particles necessary for forming a small organized body, similar in every respect to that from which the fluid is extracted? May not a force similar to that which is the cause of growth, be sufficient to collect the superfluous organic particles, and bestow on them the figure of the body from which they proceed?

That our food contains an immense number of organic particles, requires no formal proof; since we are solely nourished by animals and vegetables, which are organized substances. In the stomach and intestines, the gross parts of the aliment are separated and rejected by the excretaries.

ories. The chyle, which is a purer part of the aliment, is absorbed by the lacteal vessels; from thence it is carried into the mass of blood, and, in the course of circulation, it is more and more refined, the unorganic and useless particles being thrown out by transpiration and other secretions: But the organic particles are retained, because they are analogous to the blood, and are attracted by it. Hence, as the whole mass of blood passes several times through the body, during the course of this perpetual circulation, I suppose, that each particular part attracts those particles which are most analogous to it, and allows the rest to move on. In this manner all the parts are nourished and unfolded, not, as is commonly imagined, by a simple addition of matter to their surfaces, but by an intimate penetration of substance, effected by a force which acts equally upon every point of the whole mass: And, after the different parts have acquired their utmost growth, and are fully impregnated with similar organic particles, as their substance becomes then more dense and solid, I imagine that they lose their faculty of attracting and receiving the particles presented to them. But, as the particles continue to be carried round in the course of the circulation, and are no longer absorbed in such quantities as formerly, they must, of necessity, be deposited in some particular reservoir, such as the testicles and seminal vessels. When this fluid extract of the male is mixed with

with that of the female, the particles which are most analogous to each other, being actuated by a penetrating force, unite and form a small organized body, similar to the one or the other sex ; and this body, when once formed, requires only an expansion of its parts, an operation which is performed in the womb of the mother.

We shall now consider the second question, namely, Whether the female has a seminal fluid similar to that of the male ? In the *first* place, though such a fluid exists in females, the mode of emission is very different from that of the male, being generally confined within the body *. The ancients were so confident of the existence of a female fluid, that they distinguished the two sexes by their different modes of emission. But those physicians who attempt to explain generation by eggs, or by spermatic animalcules, insist, that females have no peculiar fluid ; that the mucus issuing from the parts has been mistaken for a seminal fluid ; and that the opinion of the ancients on this subject is destitute of foundation. This fluid, however, does exist ; and the doubts concerning it have arisen solely from attachment to systems, and from the difficulty of discovering its reservoir. The fluid which is separated from the glands about the neck and orifice of the uterus, has no visible reservoir ; and, as it flows out of the body, it is natural to think that it is

not

* *Quod intra se semen jacit, foemina vocatur ; quod in hac jacit, mas ; Aristot. de animalibus, art. 18.*

not the prolific fluid, because it cannot co-operate in the formation of the foetus, which is performed within the uterus. The reservoir for the prolific fluid of the female, therefore, must be situated in a different part : It even flows abundantly ; though, like that of the male, a small quantity is sufficient to produce a foetus. If a little of the male fluid enters the uterus, either by its orifice or by absorption, and meets with the smallest drop of the female fluid, it is sufficient for the purpose of propagation. Thus, neither the observations of some anatomists, who maintain that the seminal fluid of the male can have no admission into the uterus, nor the opposite opinion maintained by their antagonists, have any influence upon the theory we are endeavouring to establish. But the discussion of these points we leave to a future opportunity.

Having obviated such objections as might be made, let us attend to the evidences which concur in supporting our hypothesis. The first arises from the analogy between growth and reproduction. It is impossible to give a satisfactory account of growth or expansion, without having recourse to those penetrating forces, those affinities or attractions which we employed in explaining the formation of the small organic bodies, that are similar to the large bodies which contain them. A second analogy is derived from this circumstance, that both nutrition and reproduction proceed, not only from the same efficient,

cient, but from the same material cause, namely, the organic particles of food ; and what proves the surplus of the nutritive particles to be the cause of reproduction, is, that the body is not in a condition to propagate till its growth be finished : Of this we have daily examples, in dogs and other animals, who follow, more closely than we do, the laws of Nature : They have no inclination to propagate till they have nearly attained their full growth ; and by this we know whether the growth of a dog be finished ; for he seldom grows after being in a condition to generate.

Another proof that the seminal fluid is formed of the surplus of the nutritive particles, arises from the condition of eunuchs and other mutilated animals : In this unnatural state, animals grow fatter than those who retain all their parts. The superabundance of nutriment, having no organs for its evacuation, changes the whole habit of their bodies. The knees and haunches of eunuchs grow uncommonly large. The reason is evident. After their bodies have acquired the common size, if the superfluous organic particles found an issue, as in other men, the growth would proceed no farther. But, as they want organs for emitting the seminal fluid, which is nothing but the superfluous nutritive particles, it remains in the body, and has a constant tendency to expand the parts beyond their natural size. Now, bones, it is well known, grow or extend

extend by their extremities, which are soft and spongy, and, when they have once acquired solidity, they are incapable of farther extension: Hence the superfluous organic particles can only enlarge the spongy extremities of bones; and this is the reason why the haunches, knees, &c. of eunuchs augment to a disproportioned bulk.

But the strongest proof of the truth of our present doctrine arises from the resemblance of children to their parents. Sons, in general, resemble their fathers more than their mothers, and daughters have a greater resemblance to their mothers than their fathers; because, with regard to the general habit of body, a man resembles a man more than a woman, and a woman resembles a woman more than a man. But, as to particular features or habits, children sometimes resemble the father, sometimes the mother, and sometimes both. A child, for example, will have the eyes of the father, and the mouth of the mother, or the colour of the mother and the stature of the father. Of such phenomena it is impossible to give any explication, unless we admit that both parents have contributed to the formation of the child, and, consequently, that there has been a mixture of two seminal fluids.

These resemblances long embarrassed me, and, till I had maturely considered the subject of generation, led me into many errors and prejudices: And it was not without much thought, a minute examination

examination of a great number of families, and a multiplicity of evidence, that I could prevail on myself to alter my former opinion, and to embrace what I now believe to be truth. But the objections which might occur concerning mulattoes, mongrels, mules, and particular parental resemblances, instead of opposing my theory, I despair not of being able to show that they bestow on it an additional strength.

In youth, the seminal fluid is less copious, but more stimulating. Its quantity continues to augment till a certain age; because, in proportion as we approach that age, the parts of the body become more solid, admit fewer nutritive particles, send back more of them to the common reservoirs, and, of course, augment the quantity of the seminal fluid. Thus, if the external organs have not been used, middle-aged men, or even old men, procreate with more ease than young men. This is evidently the case with the vegetable tribes: A tree, the older it is, produces the greater quantity of fruit.

Young people, who, by forced irritations, determine an unnatural quantity of this fluid into the reservoirs prepared for its reception, immediately cease to grow, lose their flesh, and at last fall into consumptions. The reason is apparent: They lose, by premature and too frequent evacuations, the very substance which Nature intended for the nourishment and growth of their bodies.

Men who are thin, but not emaciated, and those who are plump, but not fat, are the most vigorous. Whenever the superabundant nutritive particles begin to form fat, it is always at the expence of the seminal fluid and other generative powers. When the growth of the different parts of the body is complete, when the bones have acquired full solidity, when the cartilages begin to ossify, and, lastly, when the parts almost refuse the admission of nutritive particles, then the fat augments considerably, and the quantity of seminal fluid diminishes; because the nutritive particles, instead of being sent back to the reservoirs, are arrested in every part of the body.

The quantity of seminal fluid not only increases till we arrive at a certain age, but it becomes more thick. It contains, in the same bounds, a greater quantity of matter. Its specific gravity is nearly double that of the blood; and, of course, it is heavier than any other animal fluid.

To a man in health, an evacuation of this fluid whets the appetite: He soon finds the necessity of repairing the loss by fresh nourishment. Hence we may conclude, that abstinence and hunger are the most effectual checks to luxury of every kind.

Many other remarks might be made on this subject, which must be deferred till we come to treat of the history of man: We shall, therefore, conclude

conclude with a few observations. Most animals discover no inclination for the sexes till their growth be nearly finished: Those which have but one season in the year, have no seminal fluid, except at that time. Mr Needham* not only saw this liquor forming in the milt of the *Calmar*, but likewise the spermatic animals, and the milt itself, which have no existence till the month of October, when this fish spawns on the coasts of Portugal, where Needham made the observation. After the spawning time is over, the seminal liquor, the spermatic animals, and the milt, dry up and totally disappear; till the same season returns next year, when the superfluous nutritive particles renew the milt as formerly. The history of the deer will furnish us with an opportunity of remarking the various effects of rutting, the most conspicuous of which is the extenuation of the animal; and, in those species of animals whose rutting and spawning happens but once in a year, the extenuation of their bodies is proportionally great.

As women are smaller and weaker than men, as their constitutions are more delicate, and, as they take less food, it is natural to think that their superfluous organic particles should also be less abundant: Of course, their seminal fluid will be weaker and smaller in quantity than that of men; and, since the fluid of females contains fewer organic particles, must not a greater number

* See Needh. new microscopical discoveries, London 1745.

ber of males than of females result from a mixture of these two fluids? This is really the case; and to account for it has hitherto been deemed impossible. The number of males born exceeds that of females about a sixteenth part; and we shall afterwards see that the same effect is produced by the same cause in all the different species of animals.

C H A P.

C H A P. V.

Examination of the different Systems of Generation.

PLATO, in the Timaeus, accounts not only for the generation of men, of animals, of plants, and of the elements, but even of the heavens and of the gods themselves, by images reflected or extracted from the divine Creator; which images, by an harmonic movement, are arranged in the most perfect order, according to the properties of number. The universe, he says, is a copy of the Deity; time, space, motion, and matter, are the images or representations of his attributes; and seconday and particular causes are results of the numeric and harmonic qualities of these images: The world, from its excellency, is the most perfect animated being. To give the world complete perfection, it was necessary that it should contain all the other animals, or all the possible forms and representations of the creative power. Man is one of these forms. The essence of all generation consists in the unity and harmony of the number Three, or of the Triangle, namely, that which generates, that in which generation is performed, and the result, or that which is generated. The succession of individuals in the species,

species, is only a fugitive image of the immutable eternity of this harmonic triangle, a universal prototype of all existences, and of all generations.

This philosopher paints only ideas. Disengaged from matter, he flies into the regions of abstraction; and, losing sight of sensible objects, he contemplates those of intellect alone. One cause, one end, one mean, compose the whole of his perceptions: God is the cause, perfection the end, and harmonic representations the means. This idea is sublime; the mode of philosophising is noble and full of simplicity; but it is perfectly vacant, and affords no objects for speculation. We are not pure intelligences. We are unable to give real existence to our ideas. Chained to matter, or rather depending on the causes of our sensations, it is impossible that we should realise abstractions. To Plato I might reply in his own manner, ‘The Creator realises ‘every thing he conceives; his perceptions be- ‘get existence: The created being, on the con- ‘trary, conceives nothing but by retrenching ‘from reality; and annihilation is necessary to ‘bring forth his ideas.’

Let us, without regret, therefore, confine ourselves to a philosophy more humble and more material; and, keeping within the sphere which nature has allotted us, let us examine those rapid and daring spirits who attempt, though in vain, to fly beyond the limits of humanity. The whole

of this Pythagorean philosophy, which is purely intellectual, depends upon two principles, the one false, and the other uncertain; namely, the real power of abstraction, and the natural existence of final causes. To apprehend numbers to be real beings; to say that unity is a general individual, which not only represents all individuals, but even communicates existence to them; to pretend that unity exercises the actual power of engendering another unity nearly resembling itself, and of creating two individuals, two sides of a triangle, that can have no connection or perfection without a third side, which is necessarily produced by the other two; in fine, to regard numbers, geometrical lines, and metaphysical abstractions, as real and efficient physical causes, by which the elements are formed, plants and animals regenerated, and all the phaenomena of Nature produced, appears to be a most absurd abuse of human reason, and an invincible obstacle to the advancement of knowledge. Besides, nothing can be more fallacious than such chimeras. Supposing we should agree with Plato and Malbranche, that matter has no existence, that external objects are only ideal images of the creative power, and that we see every thing in the Deity himself; does it follow, that our ideas are of the same order with those of the Creator, and that they can produce real existences? Are we not dependent on our sensations? Whether the objects which excite sensations

sensations be real or imaginary, whether they exist without or within, whether it be God or matter that we every where behold, is to us of little importance: We are not less certain of being uniformly affected in the same manner by the same causes. The relations between our senses and the objects which affect them are necessary and invariable. It is upon this basis alone that the principles of philosophy ought to be founded, otherwise our knowledge must be useless and fallacious. Can an harmonic triangle create the substance of the elements? Is fire, as Plato affirms, an acute triangle, and light and heat two properties of this triangle? Are water and air rectangular and equilateral triangles? Is the form of the element of earth a square, because, being the least perfect of the four elements, it recedes as far as possible from a triangle, without departing altogether from its essence? Do males and females embrace each other for no other purpose but to complete the triangle of generation? These Platonic ideas have two different aspects: In speculation, they seem to proceed from sublime principles; but the application of them in practice leads to nothing but false and childish conclusions.

Is it difficult to perceive that our ideas originate from our senses alone; that the objects we regard as real existences are those concerning which the senses uniformly give the same testi-

mony; that the objects we apprehend as having a real existence, are those which are invariably presented to us in the same manner; that the mode in which they present themselves has no dependence upon our will or inclination; that, of course, our ideas, instead of being the causes of things, are only particular effects, which become less similar to the objects themselves, in proportion as they are rendered more general; and, lastly, that mental abstractions are only negative beings, which derive their intellectual existence from the faculty we possess of considering objects, without regarding their sensible qualities?

Is it not, therefore, apparent, that abstract ideas can never be the principles of existence, or of real knowledge? On the contrary, all our knowledge is derived from comparing and arranging the results of our sensations. These results are known by the appellation of *experience*, the only source of genuine science. The employment of any other principle is an abuse; and every edifice founded upon abstract ideas, is a temple erected to Error.

In philosophy, error has a more extensive influence than in morals. A thing may be false in morals solely because it is misrepresented. But falsehood in metaphysics consists not in misrepresentation alone, but in taking for granted what has no existence at all. It is into this most pernicious species of error that the Platonists and the

the Sceptics have fallen. Their false suppositions have obscured the natural light of truth, bewildered the reasoning faculties of men, and retarded the progress of philosophy.

Final causes are employed as a second principle by Plato and other theorists. This principle has even been adopted by the vulgar, and by some modern philosophers. A moment's reflection, however, will be sufficient to reduce this principle to its proper value. To say that light exists because we have eyes, and that sounds exist because we have ears; or to say that we have eyes and ears, because light and sounds exist; is not this precisely the same thing? or, rather, are we any wiser by this kind of reasoning? Will we ever make any discoveries by such a mode of explication? Is it not apparent, that final causes are only arbitrary relations and moral abstractions, which ought to have less influence than abstractions in metaphysics, because the origin of the former is less noble and worse imagined? And, though Leibnitz has endeavoured to give an elevation to final causes, under the appellation of the reasonableness and eternal fitness of things, [*raison suffisante*], and Plato has represented them under the flattering picture of absolute perfection; all these efforts are insufficient to cover their native insignificance and precariousness. Are we better instructed in the operations of Nature, because we are told that nothing exists without a reason, or that every

thing is created with a view to the perfection of the whole ? What is reasonableness or fitness ? What is perfection ? Are they not moral beings, created solely by the human intellect ? Are they not arbitrary relations which we have contrived to generalise ? They have no foundation but in moral affinities, which, so far from producing any physical or real existence, change the nature of truth, and confound the objects of our sensations, of our perceptions, and of our understandings, with those of our sentiments, of our passions, and of our wills *.

Much

* The translator thinks it his duty to apprise the reader, that here, as well as in several other parts of this work, the author makes an ingenious attack against the existence and utility of final causes. Every philosopher will admit the absurdity of employing a final cause as a physical principle. M. de Buffon, if he meant only to expose the misapplication of final causes, had no occasion to betray so much warmth and anxiety about an object so apparent. But, like too many of our modern French writers, he seems to neglect the distinction between final and physical causes. Final causes regard the design or the utility of particular objects, whether that utility relates to man, to the objects themselves, or to the general structure of the universe. But physical causes are limited to the explanation of particular effects, or modes of existence. *Why* were mountains, seas, or insects, created ? *What* useful purposes do they serve ? For the solution of these, and similar questions, final causes can alone be employed. But if it be asked, *How* were mountains and seas formed ? *How* were insects originally produced ; and *how* are their different species propagated ? These are questions purely physical.

It may be farther remarked, that final causes are the greatest stumbling-blocks which lie in the way of atheists and materialists.

They

Much more might be said upon this subject. But I pretend not to write a treatise on philosophy; and shall therefore return to physics, from which the ideas of Plato, concerning universal generation, have diverted my attention. Aristotle, who was as great a philosopher as Plato, and a better physician, instead of wandering in the regions of theory, collects facts, and speaks in a language more intelligible.

Matter, he remarks, which is only a capacity of receiving forms, assumes, in generation, a figure similar to the individual which furnishes it: And, with regard to animals which generate by the intervention of sexes, he imagines, that the prolific principle proceeds solely from the male *: For though, in another place, when speaking of animals in general, he says, that the female sheds

They, accordingly, strain every nerve to remove them. But their force is so irresistible; their numbers are so immense; their beauties are so striking, and correspond so intimately with the warm and benevolent feelings of the heart; the concatenation and mutual dependence of all created beings recognisable by our senses are so apparent, and so illustrious, that no powers of sophistry, no artful misrepresentations, no strokes of ridicule, will ever be able to diminish their influence, or weaken the force of those sentiments which the Supreme Being intended they should excite in the breasts of his intelligent creatures. Final causes not only demonstrate the existence of a Supreme Intelligent Power, but the infinite beneficence, and minute attention of that power to the happiness of those beings upon whom He has thought proper to confer existence.

* See Aristot. de Gen. lib. 1. cap. 20. and lib. 2. cap. 4.

sheds a seminal fluid within the body, it appears, that he regards not this fluid as a prolific principle; and yet he tells us, that the menstrual blood serves for the formation, nourishment, and growth of the foetus; but that the efficient principle exists alone in the seminal fluid of the male, which acts not as matter, but as a cause. Averrhoes, Avicenna, and other philosophers who embraced this opinion of Aristotle, have endeavoured to prove that females have no prolific fluid. They alledge, that, as females are furnished with a menstrual fluid, which is both necessary and sufficient for the purposes of generation, it is unnatural to suppose them possessed of any other, especially since it begins to appear, like that of the male, at the age of puberty. Besides, they continue, if females really have a prolific seminal fluid, why do they not produce without the intercourse of the male, since they contain the prolific principle, "as well as the matter necessary for the growth and expansion of the embryo? This last reason is the only one which merits attention. The menstrual blood appears to be necessary for the growth and nourishment of the foetus; but still it may contribute nothing to its first formation, which requires the mixture of both prolific fluids. Females, therefore, like males, may have a prolific fluid for the formation of the embryo, as well as menstrual blood for its growth and nourishment. The imagination is not unnatural,

ral, that, as the female possesses both a prolific fluid extracted from all parts of her body, and likewise the means of expanding and nourishing, she should produce females without any communication with the male. It must be allowed, that this metaphysical argument used by the Aristotelians for proving that females are destitute of a prolific fluid, may be urged as the strongest argument against every system of generation, and, in particular, against that which I am endeavouring to establish.

Let us suppose, it may be said, that the superfluous organic particles are sent from every part of the body into the testicles and seminal vessels of the male, why do they not, by means of your imaginary attracting forces, form small organized bodies similar to the whole? Why are not similar bodies generated in the female, without any intercourse with the male? If you answer, that the male fluid contains only males, that the female fluid contains only females, that both perish for want of the circumstances necessary for expansion, and that, for the procreation of an animal, a mixture of both is requisite; may it not be demanded, why this most complicated, difficult, and less fertile mode of generation, is so invariably preferred by Nature, that all animals, with a few trifling exceptions, generate by the mutual commerce of sexes?

I shall content myself, at present, with replying, that this is the mode actually employed by Nature;

Nature; and, therefore, however complicated it may appear, it is, in fact, the most simple; because, as I formerly remarked, whatever most frequently happens is, in itself, however it may seem to us, the most simple.

Besides, the notion of the Aristotelians, that females have no seminal fluid, cannot receive our assent, if we consider the strong resemblance of children to their mothers, and that mules, mulattoes, and mongrels of every kind, uniformly resemble the mother more than the father; and, if it be farther considered, that the generating organs of the female, like those of the male, are properly formed for preparing and receiving a seminal fluid, we shall be easily induced to believe the existence of such a fluid, whether it resides in the spermatic vessels, the testicles, or the ovaria, or proceeds, by irritation, from the lacunae of De Graaf, which are situated at the neck and near the orifice of the uterus.

But we must examine Aristotle's ideas more fully, as, of all the ancients, this great philosopher has treated the subject of generation in the most extensive manner. He distinguishes animals into three classes: 1. Those that have blood, and, with few exceptions, propagate by copulation; 2. Those that have no blood, and, being hermaphrodites, produce of themselves without copulation; and, 3. Those that proceed from putrefaction, and have no parents of any kind. I shall first remark, that this division is exceedingly

ingly improper: Though it be true, that animals having blood are distinguished into male and female, it is by no means equally true, that bloodless animals are, for the most part, hermaphrodites: For the only hermaphrodites we know, are land-snails and worms; but we are uncertain whether all shell-animals, and all those which have no blood, be also hermaphrodites. This must be learned from the particular histories of these animals. And, with regard to those which are alledged to proceed from putrefaction, as Aristotle gives no enumeration of them, many objections occur; for most species which the ancients believed to proceed from putrefaction, have, by the moderns, been discovered to proceed from eggs.

Aristotle makes a second division of animals, namely, into those which have the faculty of progressive motion, and those which have no such faculty. All animals who move, and have blood, are distinguished by sexes: But those which, like oysters, adhere to one place, or hardly move at all, have no sexes, and, in this respect, resemble plants; and it is only, he observes, from difference in bulk that they have been distinguished into male and female. It must be acknowledged, that we are still uncertain whether shell-animals have sexes: Among oysters, some individuals are fertile, and others not. The fertile individuals are distinguished by a delicate edging or border which surround their bodies, and

and they are called males *. Our observations on this subject are extremely limited.

But to proceed. The male, according to Aristotle, contains the principle of motion, and the female the material part of generation. The organs destined for this purpose are different in different animals. Of these the testicles are the chief in males, and the uterus in females. Quadrupeds, birds, and cetaceous animals, have testicles ; fishes and serpents are deprived of them ; but they have two canals for the reception and maturation of the semen : These parts, so essential to generation, are always double both in males and females ; and, in the male, they retard the motion of that part of the blood which goes to the formation of semen. This he proves from the example of birds whose testicles swell considerably during the season of their amours, but afterwards diminish so much, that they can hardly be discovered.

All quadrupeds covered with hair, and the cetaceous fishes, as whales and dolphins, are viviparous : But vipers and cartilaginous animals are not properly viviparous ; because they produce an egg within their own bodies, previous to the exclusion of the live animal. Oviparous animals are of two kinds ; those which produce perfect eggs, as birds, lizards, turtles, &c. and those which produce imperfect eggs, as fishes, whose eggs augment and come to perfection

* See Deslandes dans son traité de la marine. Paris 1747.

tion after they have been deposited in the water by the female: And, in every species of oviparous animals, except birds, the females are larger than the males, as in fishes, lizards, &c.

After remarking these general varieties in the animal kingdom, Aristotle begins with examining the opinion of the ancient philosophers, that the semen, both of the male and female, was extracted from all parts of the body; and he dissents from this opinion; because, says he, though children often resemble both father and mother, they sometimes also resemble their grandfathers. Besides, they resemble their fathers and mothers in the voice, in the hair, in the nails, and in the gate and manner of walking. Now, he proceeds, it is impossible for the semen to come from the hair, from the voice, from the nails, or from any external quality, as that of the mode of walking. Infants, therefore, resemble not their parents because the semen proceeds from all parts of the body, but for other reasons. I will not expose the weakness of these arguments; but shall only remark that this great man appears to have been anxious to differ from the sentiments of former philosophers: And I am persuaded, that, whoever peruses his treatise on generation, will discover that a strong passion for establishing a system different from that of the ancients, obliges him uniformly to prefer arguments of little probability, to the force

force of proofs, when they stand in opposition to the general principles of his philosophy.

The seminal liquor of the male, according to Aristotle, is secreted from the blood; and the menstrual fluid of the female is likewise a secretion from the blood, and the only matter which contributes to generation. Females, he continues, have no other prolific fluid; no mixture, therefore, of male and female fluid takes place: This notion he attempts to prove by observing, that some women conceive without pleasure; that few emit any fluid during the time of copulation; that, in general, those who are brown, and have a masculine air, have no emission; and yet their powers of procreation are not less than those of a fairer complexion and more delicate appearance, who emit copiously. Thus, he concludes, women furnish nothing for the purposes of generation, but the menstrual blood. This blood is the matter of generation, and the male fluid contributes nothing but the form: The male fluid is the efficient cause, and the principle of motion; it is to generation what the sculptor is to a block of marble: The seminal fluid is the sculptor, the menstrual blood the marble, and the foetus the figure. The menstrual blood receives from the male semen a kind of soul, which gives it life and motion. This soul is neither material nor immaterial, because it can neither act upon matter, nor augment the menstrual blood, which is the only matter necessary

fary to generation. It is a spirit, says our philosopher, similar to that of the element of the stars. The heart is the first production of this soul, which is the cause of its own growth, and of the growth and disposition of all the other members. The menstrual blood contains the *capacities* of all the parts of the foetus; the soul or spirit of the male semen makes the heart begin to *act*, and communicates to it the powers of bestowing *action* on the other viscera; and, in this manner the different parts of the animal are successively unfolded. All this appears clear and luminous to our philosopher. He has only one doubt, namely, whether the blood or the heart is first realized. And of this he doubted not without reason; for, though he adopted the opinion that the heart received its existence first, Harvey has since alledged, from arguments similar to those of Aristotle, that the blood, and not the heart, is first realized.

Thus have I given a short view of what Aristotle has delivered on the subject of generation, and shall leave the reader to consider whether any system of the ancients be more obscure, or more absurd, than that which he has endeavoured to establish. His system, however, has been adopted by most men of learning. Harvey has borrowed many of Aristotle's notions; but he has also adopted some of his own, which are by no means better founded. It is not surprising that Aristotle's theory of generation, which

which was a result of his system of philosophy, where form and matter are the great principles, where vegetable and sensitive souls are the agents of Nature, and where final causes are real objects, should have been received in the schools: But it is not a little astonishing to see a physician and an acute observer, like Harvey, carried down the stream, while, at the same time, most philosophers followed the sentiments of Hippocrates and Galen, of which we shall afterwards take notice.

We mean not to convey a disadvantageous idea of Aristotle by the account we have given of his theory of generation. We might with equal propriety judge of Descartes by his treatise on man. What these two philosophers have remarked concerning the formation of the foetus should rather be considered in the light of detached observations, or as consequences which each of them drew from their principles of philosophy, than as complete systems. Aristotle admits, with Plato, final and efficient causes: The latter are the sensitive and vegetable souls, that give form to matter, which, in itself, is only a *capacity* of receiving forms: And as, in generation, the female furnishes the greatest quantity of matter, and as it was repugnant to his system of final causes, that any effect should be produced by two causes, when one was sufficient for the purpose, he concludes, that the woman alone contains the matter necessary for procreation:

tion: Again, another of his principles is, that matter, in itself, has no form, and that *form* is a being distinct from matter; he therefore maintains, that the male furnishes the form, and, of course, that he contributes nothing *material*.

Descartes, on the contrary, admitted into his philosophy a few mechanical principles only. By these he attempted to explain the formation of the foetus; and he imagined that he understood, and was able to communicate to others, the manner in which a living organized body could be formed by the laws of motion alone. The principles he employed were different from those of Aristotle. But both of them, instead of directing their inquiries to the subject itself, in place of examining it with impartiality, considered it only in relation to their philosophic principles, which could never be applied with success to the nature of generation, because it depends, as has been already shown, upon very different principles. Descartes, however, admits the existence and necessary concurrence of the seminal fluids of both sexes. He allows that both furnish something material for the purposes of generation; and that the fermentation occasioned by a mixture of the two fluids, is the cause of the formation of the foetus.

Hippocrates, who lived about five or six hundred years before Aristotle, taught an opinion, which was adopted by Galen, and by most physicians, for many ages. He maintained the ex-

istence of a female fluid; and even that both male and female had two fluids, the one strong and active, the other weaker and more sluggish *. A concurrence of the two stronger fluids produced a male child, and, of the two weaker, a female. Thus, according to Hippocrates, there exist two kinds of seminal fluids both in the male and in the female. This notion he supports in the following manner: Several women who produced girls only by their first husband, have had boys by their second; and the same thing has often happened to men who have had two wives. Supposing this to be fact, it admits of an easy explanation, without having recourse to two different fluids peculiar to each sex; for the women who had girls only by the first husband, and boys by the second, furnished a greater quantity of particles proper for generation during the first, than the second marriage; or the second husband furnished a greater quantity of generating particles during the time of the second marriage, than the first. If, at the moment of conception, the organic particles of the male are more abundant than those of the female, a male child is the result; and, when the organic particles of the female most abound, a female child is the consequence: It is not, therefore, surprising, that the husband should be foiled with some women, and have the superiority over others.

It

* See Hippocrat. lib. de Genitura, p. 129. et lib. de Diaeta, p. 198. Lugd. Bat. tom. 1. 1665.

It is farther alledged by Hippocrates, that the male semen is secreted from the strongest and most essential fluids of the body; and he thus explains the manner in which the secretion is performed: 'Venea et nervi,' says he, 'ab omni corpore in pudendum vergunt, quibus dum aliquantulum teruntur, et calefcunt ac implentur, velut pruritus incidit, ex hoc toti corpori voluptas ac caliditas accidit; quum vero pudendum teritur et homo movetur, humidum in corpore calefcit ac diffunditur, et a motu conquassatur ac spumescit, quemadmodum alii humores omnes conquassati spumescunt.'

'Sic autem in homine ab humido spumescente id quod robustissimum est ac pinguissimum fecer-
nitur, et ad medullam spinalem venit; tendunt enim in hanc ex omni corpore viae, et diffun-
dunt ex cerebro in lumbos ac in totum corpus et in medullam: Et ex ipsa medulla procedunt viae, ut et ad ipsam humidum perforatur et ex ipsa secedat; postquam autem ad hanc medul-
lam genitura pervenerit, procedit ad renes, ac enim via tendit per venas; et si renes fuerint exulcerati, aliquando etiam sanguis defertur: A renibus autem transit per medios testes in pu-
dendum, procedit autem non qua urina, verum alia ipsi via est illi contigua*', &c.

It will, doubtless, be perceived by anatomists, that Hippocrates errs in tracing the route of the seminal fluid. But this error effects not his hy-

* See Fesius's translations, tom. I. p. 129.

pothesis, that the semen proceeds from every part of the body, and particularly from the head ; because he remarks, those who have had the veins behind their ears cut, secrete only a weak and often an unfertile semen. The female likewise sheds a seminal fluid sometimes within the uterus, and sometimes without it, when the orifice is too open. The male semen enters the uterus and mixes with that of the female ; and as each has two species of fluid, the one strong and the other weak, if both of them furnish the strong kind, a male foetus is the consequence ; and, if both furnish the weak kind only, the result is a female : Besides, if in the mixture there are more particles of the male than of the female fluid, the child will resemble the father more than the mother ; *et e contra.* Here we might ask him, what would happen, when the fluid of the one was strong and that of the other weak ? I cannot conceive what reply could be made to this question ; and, therefore, we are warranted to reject the opinion of two distinct fluids in each sex as perfectly chimerical.

Let us now attend to his account of the formation of the foetus. The seminal fluids first mix in the uterus, and gradually thicken by the heat of the mother. The mixture extracts the spirit of heat, and, when too warm, part of the heat escapes into the air. But a cold spirit is likewise conveyed to it by the respiration of the mother : Thus a cold and a hot spirit alternately

enter

enter the mixture, give life to it, and cover its surface with a pellicle, which assumes a round figure, because the spirits acting in the centre, expand the matter equally on all sides. I have seen, says this great physician, a foetus of six days old: It was a ball of liquor inclosed in a pellicle. The liquor was reddish; and the pellicle was interspersed with red and colourless vessels. In the middle of it there was a small eminence, which I apprehended to be the umbilical vessels, by which the foetus receives nourishment and the spirit of respiration from the mother. A second covering or pellicle gradually forms above the first. Abundance of nourishment is furnished by the menstrual blood, which coagulates by degrees, and is converted into flesh. This flesh gradually articulates as it grows; and the spirit bestows upon it this form. Every part assumes its proper place; the solid particles unite; the moist particles associate by themselves; every thing searches for what is analogous to it; and, in fine, the foetus, by these causes and means, is completely formed.

This system is more rational, and less obscure than that of Aristotle; because Hippocrates endeavours to explain every particular appearance, and borrows one general principle only from the philosophy of his times, namely, that heat and cold produce spirits, and that these spirits have the power of arranging and of bestowing

figure upon matter. He treats his subject more like a physician than a philosopher; but Aristotle explains the phaenomena of generation more as a metaphysician than a naturalist. It is for this reason that the errors of Hippocrates are particular and less apparent, and that those of Aristotle are general and evident.

These two great men have each had their followers. Almost all the philosophers of the schools adopted Aristotle's theory of generation, while most physicians adhered to the theory of Hippocrates; and, in this manner, 17 or 18 centuries passed without the appearance of any thing new upon this mysterious subject.

At last, upon the revival of literature, some anatomists began to investigate the nature of generation; and Fabricius ab Aquapendente was the first who thought of making a course of experiments upon the impregnation and expansion of the eggs of fowls, the substance of which we shall lay before the reader.

He distinguishes the matrix of a hen into two parts, the one superior, and the other inferior. The superior part, which he calls the ovarium, is an assemblage of a great number of small yellow eggs, of a round figure, the sizes of which vary from that of a mustard seed to that of a walnut. These eggs are attached to one another by foot-stalks, and the whole somewhat resembles a bunch of grapes. The smallest

eggs

eggs are white, and they turn yellower in proportion as they increase.

Having examined those yellow eggs immediately after a communication with the male, he could perceive no sensible difference ; he saw none of the male semen in any part of the eggs : He therefore concluded, that the whole eggs, and even the ovarium itself, were rendered fertile by a subtle spirit which issues from the male semen ; and, he adds, that, in order to prevent the escape of this fecundating spirit, Nature has placed, at the external orifice of the vagina of birds, a membranous valve which permits the seminal spirit to enter freely into the vagina, but prevents its return.

When an egg is detached from the common pedicle, it gradually descends, through a winding canal, into an inferior part of the matrix. This canal is filled with a liquor very similar to the white of an egg. It is here that the egg receives its white liquor, the membrane in which it is inclosed, the two cords (*chalazae*) that run through the white, and join it to the yolk, and the shell which is suddenly formed immediately before exclusion. These cords, according to our author, are the part of the egg which is impregnated by the seminal spirit of the male ; and it is here also that the rudiments of the foetus first appear. The egg is not only the true matrix, or the place where the chick is formed, but the whole business of generation depends upon it.

it. The egg is the great agent in generation; it furnishes both the matter and the organs. The substance of the cords is the matter of which the chick is formed; the white and the yolk afford it nourishment; and the seminal spirit of the male is the efficient cause. This spirit communicates to the cords, first, an alterant quality, then a forming quality, and, lastly, a power of augmenting, &c.

These observations of Fabricius, it is apparent, lead not to any clear idea of generation. At the same time that this anatomist was making his experiments, which was about the middle of the sixteenth century, the famous Aldrovandus* made some remarks upon eggs. But, as Harvey properly observes of him, he followed more the authority of Aristotle than of experiment. The description he gives of the chick in the egg is by no means exact. Volcher Coiter, one of his pupils, succeeded better than his master; this writer, together with Parisanus, a Venetian physician, have each given descriptions of the chick in the egg, which Harvey prefers to all the others.

This celebrated anatomist, who first discovered the circulation of the blood, has given an excellent treatise on generation. He flourished about the middle of last century, and was physician to Charles I. of England. As he was obliged to follow this unhappy Prince during his misfortunes,

* See his *Ornithologia*.

misfortunes, he lost, among other papers, what he had written concerning the generation of insects; and it appears, that he composed from memory his treatise on the generation of birds, and of quadrupeds. I shall give a short view of his remarks, of his experiments, and of his theory.

Harvey alledges, that men, and all other animals, proceed from eggs; that, in viviparous animals, the first produce of conception is a kind of egg; and that the only difference between the viviparous and oviparous is, that, in the former, the foetuses begin to exist, increase, and acquire their full growth in the uterus; but that, in the oviparous animals, the rudiments of the foetuses begin to exist in the body of the mother, where they are in the form of eggs; and it is only after their exclusion that they become real foetuses. And it deserves to be remarked, says he, that, in oviparous animals, some retain their eggs till they be perfect, as birds, serpents, and oviparous quadrupeds; and that others exclude their eggs before they are perfect, as fishes, crustaceous and testaceous animals. The eggs laid by these creatures are only the rudiments of eggs, which afterwards acquire membranes and a white, and attract nourishment from the matter with which they are surrounded. There are even, he adds, insects, caterpillars, for example, which are only imperfect eggs; they search for their nourishment, and, at the end of a certain time,

they

they arrive at the state of a chrysalis, which is a perfect egg. Another difference may still be remarked in oviparous animals: The eggs of hens, and other birds, are of all different sizes; but those of fishes, frogs, &c. which lay them before they are perfect, are all of the same size. He indeed observes, that, in pigeons, which lay two eggs, all the small eggs that remain in the ovarium are of the same bulk; and that the two only which are next to be excluded exceed the size of the rest. The same thing happens in cartilaginous fishes, as in the ray, which only brings to maturity two eggs at a time, all the rest being of different sizes, like those of the hen.

He next describes anatomically the parts necessary to generation; and remarks, that the situation of the anus and vulva in birds differ from those of all other animals, the anus being placed before, and the vulva behind *. And, with regard to the cock and all small birds, he alleges, that they have no proper penis, and that they generate by rubbing, without any intromission. But male-ducks, geese, and ostriches, are amply provided with this instrument.

Hens produce eggs without the intervention of the cock; but, though perfect, they are fewer in number, and unfertile. He credits not the common opinion, that a few days intercourse with the cock are sufficient to impregnate all the eggs which a hen will lay during the year; but

* Most of these facts are taken from Aristotle.

but he acknowledges, that he separated a hen from the cock for 20 days, and that all the eggs she laid were fecundated. As long as the egg remains attached to the ovarium, it is nourished by the vessels of the common pedicle; but, when it separates from this pedicle, it receives the white liquor and the shell from the matter with which the canal of the uterus is filled.

The two cords (*chalazae*) which Aquapendente considered to be the germ, or part produced by the male semen, are found in unimpregnated, as well as impregnated eggs; and Harvey properly observes, that these parts neither proceed from the male, nor receive the impregnation. The part of the egg which receives the impregnation is a small white circle situated upon the membrane that covers the yolk, and has the appearance of a cicatrice about the size of a lentil. Harvey likewise remarks, that this cicatrice is found in all eggs, whether they be fecundated or not; and that those are deceived who imagine it to be produced by the seed of the male. It is of the same size and form in fresh eggs as in those which have been long kept. But, as soon as the process of hatching is begun, whether by means of artificial heat, or by the heat of the hen, this small mark or cicatrice gradually augments and dilates like the pupil of the eye. This is the first change, and it is visible after a few hours incubation.

When

When the egg has been heated for 24 hours, the yolk, which was formerly in the centre, rises towards the cavity at the thick end of the egg. This cavity continues to enlarge by the evaporation of the more fluid part of the white; and the heaviest part of the white falls down to the small end. The cicatrice or speck on the membrane of the yolk, is elevated along with it, and applies itself to the membrane which lines the cavity at the thick end. This speck is now as large as a pea; and a white point is distinguishable in the middle of it, with several circles, of which this point appears to be the common centre.

At the end of the second day, these circles are larger and more conspicuous, and they divide the speck sometimes into two, and sometimes into three parts, of different colours. A small external protuberance likewise appears, which nearly resembles a little eye, with a white point or cataract on the pupil. Between the circles, a liquor, as transparent as crystal, is contained by means of a very thin membrane. The speck, which is now become a kind of bubble, or liquid globe, appears as if it were situated in the white, rather than on the membrane of the yolk. On the third day the transparent liquor, as well as the membrane in which it is inclosed, is considerably augmented. On the 4th, a small line of blood, of a purple colour, appears on the circumference of the bubble; and, at a little distance from the centre, we perceive a dot or point, of a bloody colour,

colour, which beats like a heart. It is visible at every diastole, and disappears during the systole. From this animated point two small blood-vessels issue, and terminate in the membrane which contains the transparent crystalline liquor. These blood-vessels set off from the same place, nearly in the same manner as the roots of a tree set off from the trunk; and it is in the angle which these roots form with the trunk, and in the middle of the liquor, that the animated point is situated.

Towards the end of the fourth, or beginning of the fifth day, the animated point is so much enlarged, that it has the appearance of a small bladder filled with blood; and, by its contractions and dilatations, it is alternately filled and emptied. On the same day we distinctly perceive, that this bladder is divided into two parts, each of which dilates and contracts in the same manner. Round the shortest of the blood-vessels described above, a kind of cloud appears, which, though transparent, obscures the view of the vessel. Every hour this cloud becomes thicker; it attaches itself to the root of the blood-vessel, and seems to depend from it like a small globe. This globe extends, and appears to divide into three parts, one of which is globular, and larger than the other two; and here we perceive the rudiments of two eyes, and of the whole head: And, at the end of the fifth day, we see, in the remainder of this lengthened globe, the beginnings of the vertebrae.

On the sixth day, the parts of the head are more apparent. We distinguish the coats of the eyes, the thighs, and wings; and then the liver, the lungs, and the beak. The foetus now begins to move and to stretch out its head, though nothing but the viscera are yet formed; for the thorax, the abdomen, and all the external coverings of the fore part of the body, are still wanting. At the end of this day, or the beginning of the seventh, the claws begin to be visible; the chick opens and moves its beak; and the anterior parts of the body begin to cover the viscera. On the seventh day, the chick is entirely formed; and, from this time till it issues from the egg, nothing happens but an expansion of all the parts it acquired during the first seven days. The feathers appear on the 14th or 15th day; and, on the 21st, the chick escapes from the egg, by breaking the shell with its bill.

These experiments of Harvey appear to have been made with the greatest exactness and fidelity. We shall afterwards, however, demonstrate their imperfection, and that the author has probably fallen into the common error of making experiments, with a view to establish his favourite hypothesis, that the first animated point which appeared was the heart. But, before proceeding to this object, it is proper to give an account of his other experiments.

Every body knows the numerous experiments made by Harvey upon female deer. They receive the

the male about the middle of September. A few days after copulation, the *horns** of the uterus appear to be thicker and more fleshy than usual: They are, at the same time, more lax and flabby; and, in each of their cavities, five carunculae, or soft warts, appear. About the 26th or 28th of September, the uterus is still thicker; the five carunculae are swelled nearly to the size and form of a nurse's nipple. On opening them with a scalpel, they appeared to be filled with an infinite number of white points. Harvey pretends to have remarked, that, neither now, nor immediately after copulation, had the ovarium suffered any change; and that he never could discover, after repeated trials, the least drop of male semen in the uterus.

Towards the end of October, or the beginning of November, when the females were separated from the males, the thickness of the *horns* began to diminish; the internal surfaces of their cavities were swelled, and seemed to be glued together. The carunculae still remained; and the whole resembled the substance of the brain, being so soft that it could not be touched. Harvey tells us, that, on the 13th or 14th of November, he perceived filaments, like those of a spider's web, which traversed the cavities of the *horns*, and even that of the uterus itself. These filaments arose from the superior angle of the *horns*,

* Two fleshy processes, one of which issues from each side of the *fundus uteri*, in the form of little *horns*, and are remarkably large in some quadrupeds.

horns, and, by their number, formed a kind of membrane or empty coat. A day or two afterwards, this coat or sac was filled with a white, aqueous, viscid matter, and adhered to the uterus by means of a kind of mucilage; and the adhesion was most sensible at the superior part of the uterus, where the rudiments of the placenta began then to appear. In the third month, this sac contained an embryo of two fingers breadth in length, and also an internal sac, called the amnios, inclosing a transparent crystalline liquor, in which the foetus swam. The foetus, at first, was only an animated point, like what appeared in the hen's egg. Every thing now proceeded and terminated in the same manner as described with regard to the chick, with this only difference, that the eyes of the chick appeared much sooner than those of the deer. The animated point was visible about the 19th or 20th of November. A day or two afterwards, the oblong body, which contained the rudiments of the foetus, made its appearance. In six or seven days more, the foetus was so completely formed, that all its members, and even its sex, were distinguishable. But the heart and viscera were still bare; and it was not till a day or two after, that they were covered with the integuments of the abdomen and thorax. This is the last work, the slating of the edifice.

From these experiments upon hens and deer, Harvey concludes, that all female animals have eggs;

eggs; that in these eggs a separation of a transparent crystalline liquor, contained in a sac (*amnios*) takes place, and that another external sac (*chorion*) incloses the whole liquors of the egg; that the first thing which appears in the crystalline liquor is an animated sanguineous point; and, finally, that the formation of viviparous animals is effected in the same manner as that of the oviparous: The following is the account which he gives of the generation of both.

Generation, he observes, is an operation of the uterus alone; for not a drop of the male semen ever enters it. The uterus conceives by a kind of contagion, communicated to it by the semen of the male nearly in the same manner as the load-stone communicates a magnetic virtue to iron. This male contagion acts not only on the uterus, but on the whole body of the female, which is entirely fecundated, though the uterus alone possesses the faculty of conception, in the same manner as the brain has the sole power of conceiving ideas. The ideas conceived by the brain are similar to the images of the objects transmitted to it by the senses; and the foetus, which may be regarded as the idea of the uterus, is similar to that by which it is produced. This is the reason why children resemble their fathers, &c.

I will follow the system of our anatomist no farther: What has been said is sufficient to enable the reader to form a judgment. But we have remarks of importance to make concerning his

experiments. He has represented them in a manner the most plausible and insinuating. He appears to have repeated them often, and to have taken every necessary precaution to avoid fallacy and deception; and of course we are led to think that he has seen every thing which possibly could be discovered. Uncertainty and obscurity, however, are perceptible in his descriptions. His observations are related from memory; and he seems, though he often maintains the contrary, to have made Aristotle, more than experience, his guide; for he has seen every thing in eggs, and very little more than was mentioned by that philosopher. That the most material of his observations were made long before his own time, we shall be convinced by attending to what follows.

Aristotle knew, that the cords (*chalazae*) in eggs were of no use in the generation of the chick: ‘ *Quae ad principium lutei grandines haerent, nil conferunt ad generationem, ut quidam suspicantur* *.’ Parisanus, Volcher Coiter, Aquapendente, &c. had remarked the small cicatrice, as well as Harvey. Aquapendente believed it to be of no use; but Parisanus maintained that it was formed by the male semen, or, at least, that the white point in the middle of the cicatrice was the semen of the male, and that it was the rudiments of the foetus. ‘ *Estque, illud galli semen alba et tenuissima tunica*

* Hist. Anim. lib. 6. cap. 2.

' nica abdu^{um}, quod substat duabus communibus toti ovo membranis,' &c. Hence the only discovery proper to Harvey consists in his remarking the existence of this cicatrice, both in fecundated and unfecundated eggs; for the other writers had observed, as well as he, the dilatation of the circles, and the growth of the white point. These are all the remarks Harvey has made in his account of the two first days of incubation; what he mentions concerning the third day is a repetition only of what Aristotle delivers in the sixth book and fourth chapter of his history of animals: ' Per id tempus ascendit jam vitellus ad superiorem partem ovi acutioris, ubi et principium ovi est et foetus excluditur; corque ipsum apparet in albumine sanguinei punc^{ti}, quod punctum salit et movet se instar quasi animatum; ab eo meatus venarum specie duo, sanguine pleni, flexuosi, qui, crescente foetu, feruntur in utramque tunicam ambientem, ac membrana sanguineas fibras habens eo tempore albumen continet sub meatibus illis venarum similibus; ac paulo post discernitur corpus pusillum initio, omnino et candidum, capite conspicuo, atque in eo oculis maxime turgidis qui diu sic permanent, sero enim parvi fiunt ac confidunt. In parte autem corporis inferiore nullum extat membrum per initia, quod respondeat superioribus. Meatus autem illi qui a corde prodeunt, alter ad circumdantem

‘ cumdantem membranam tendit, alter ad luteum, officio umbilici.’

Harvey, because Aristotle says that the yolk rises to the small end of the egg, concludes that he had seen nothing himself, but that he had received his information from some other pretty accurate observer. In this accusation, Harvey evidently injures Aristotle; for the rising of the yolk to either end, depends solely upon its position during the time of incubation; for the yolk, being lighter than the white, uniformly mounts to the top, whether the large or the small end of the egg be uppermost. This observation we owe to William Langley, a physician in Dordrecht, who made experiments on the hatching of eggs in the year 1655, about 20 years before Harvey’s time *.

But, to return to the passage we have quoted. It is apparent, that the crystalline liquor, the animated point, the two circles, the two blood-vessels, &c. are described by Aristotle in the same manner as they were seen by Harvey. This anatomist maintains, that the animated point is the heart, that the heart is the first part of the foetus which is formed, and that the viscera and other members succeed. All these circumstances have been mentioned by Aristotle, and seen by Harvey; and yet that the heart is first formed is by no means consonant to truth. To be assured of this fact, we have only to repeat the same experiments,

* See Langley observ. editae a Justo Schradero, Amst. 1674.

periments, or to read with attention those of Malpighius *, which were made about 50 years after the trials of Harvey.

Malpighius carefully examined the cicatrice, which is the essential part of the egg; he found that it was large in impregnated eggs, and small in those which had received no impregnation; and he discovered, that, in eggs which had never been sat upon by the hen, the white point, mentioned by Harvey as the first part that becomes animated, is a small purse or bubble swimming in the liquor bounded by the first circle; and that the embryo is visible in the centre of this purse. The membrane of the purse, which is the amnios, being exceedingly thin and transparent, allowed him to see the foetus distinctly. Malpighius, from this first observation, concludes with propriety, that the foetus exists in the egg before incubation, and that the rudiments of the embryo are even then deeply rooted. It is unnecessary to mention how much this experiment differs from the opinion of Harvey; for he had observed nothing formed during the two first days of incubation; and, in his estimation, the first vestige of a foetus is the animated point, which appears not till the third day. But Malpighius discovered that the rudiments of the whole foetus exist before incubation is commenced.

After ascertaining this important fact, Malpighius proceeded to examine the cicatrice of unimpregnated eggs, which, as formerly re-

marked, is smaller than in those that have received an impregnation. Its margin is often irregular, and its texture sometimes differs in different eggs. Near its centre, in place of a bubble including the foetus, there is a globular mole or unorganized mass, which, when opened, presents nothing like regularity or arrangement of parts: It has only some appendages filled with a thick but transparent liquor; and this unformed mass is surrounded and enveloped in several concentric circles.

After six hours incubation, the cicatrice is considerably enlarged; and, in its centre, a bubble or globule formed by the amnios is easily distinguishable. This globule is filled with a fluid, in the middle of which the head and back-bone of the chick visibly appear. Six hours after, every thing is enlarged, and, of course, more apparent to the eye. In six hours more, that is, 18 hours after the commencement of incubation, the head is larger, and the spine is lengthened; and, at the end of 24 hours, the head of the chick appears in a bended posture, and the spine is of a whitish colour. The vertebrae are ranged on each side of the spine, like small globules; and, nearly at the same time, the wings begin to sprout, and the head, neck, and breast, are lengthened. At the end of 30 hours, nothing new appears; but all the parts are enlarged, and especially the amnios. Round this membrane may be remarked the umbilical vessels,

vessels, which are of a dark colour. In 38 hours, the chick has acquired more strength; its head is very large, and three vesicles appear in it surrounded with membranes, which likewise include the spine of the back; through which, however, the vertebrae are still visible. At the end of 40 hours, it was admirable to observe, continues our author, the chick living in the centre of the liquor of the amnios. The back-bone was increased, the head was bended, the vesicles of the brain were less bare, the rudiments of the eyes appeared, the heart beat, and the blood circulated. Here Malpighius describes vessels and the circulation of the blood; and he thought, with reason, that, though the heart did not beat till 38 or 40 hours after incubation was begun, it nevertheless existed before, as well as the other parts of the chick. But, on examining the heart in a dark chamber, he observed nothing like luminous sparks issuing from it, as Harvey seems to insinuate.

At the end of the second day, the foetus appeared swimming in the liquor of the amnios. The head, which seemed to be composed of vesicles, was bended; the back-bone and vertebrae were lengthened; the heart, which hung out of the breast, beat three times successively, because the fluid it contains is pushed from the auricle into the ventricles, from the ventricles into the arteries, and, lastly, into the umbilical vessels. He remarks, that, having separated the chick

chick from the white of the egg, the motion of the heart continued for a whole day. In 14 hours more, or 62 hours from the beginning of incubation, the chick, though stronger, remained still with its head bended in the liquor of the amnios: Veins and arteries were perceived in the brain; and the lineaments of the eyes, and of the spinal marrow, appeared. At the end of three days, the body of the chick was crooked. Beside the two eyes, five vesicles filled with liquor appeared in the head; the rudiments of the thighs and of the wings were discernible; the body began to take on flesh; and the pupils of the eyes, and likewise the crystalline and vitreous humours, were distinguishable. At the termination of the fourth day, the vesicles of the brain were nearer each other; the processies of the vertebrae were longer; the wings and thighs had become stronger, in proportion as they grew longer; the whole body was covered with an unctuous flesh; the umbilical vessels had pierced through the abdomen; and the heart was concealed within the breast, which was now shut up by a thin membrane. On the fifth, and at the end of the sixth day, the vesicles of the brain began to be covered; the spinal marrow, which was now more solid, was divided into two parts, and advanced along the trunk; the thighs and wings were longer, and the wings were unfolded; the abdomen was shut and tumified; the liver was distinctly visible, and

and it was of a dark colour; the two ventricles of the heart beat; the body of the chick was covered with skin; and the points of the feathers began to appear. On the seventh day, the head was very large; the brain was covered with its membranes; the beak appeared between the two eyes; the wings, the thighs, and the legs, had acquired their perfect form; the heart seemed to be composed of two ventricles, like two contiguous globules, united at their superior part with the auricles; and two successive pulses were remarked both in the ventricles and auricles, as if there had been two separate hearts.

But I will follow Malpighius no farther. The remainder of the detail regards the growth and perfection of the parts till the chick breaks the shell in which it is inclosed, and becomes an inhabitant of a new world. The heart is the last part that assumes its proper figure, by the union of its ventricles, which happens not till the eleventh day.

We are now in a condition to form a distinct judgment concerning the value of Harvey's experiments. It is probable that this celebrated anatomist did not make use of the microscope, (which was, indeed, very imperfectly known in his days), otherwise he never would have affirmed, that there was no difference between the cicatrice of impregnated and unimpregnated eggs; he never would have said, that the semen of the male produced no change upon the egg, and

and particularly upon the cicatrice ; he never would have advanced, that nothing was perceptible before the end of the third day ; that the animated point appeared first ; and that the white point was transformed into the animated point : He would have perceived that the white point was the bubble or globule which contained the whole apparatus of generation ; and that all the rudiments of the foetus commenced there from the moment of receiving the impregnation of the cock : He would likewise have discovered, that, without this impregnation, it contains nothing but an unformed mass, which could never become animated ; because, in fact, it is not organized like an animal, and because it is only after this mass, which ought to be regarded as a collection of the organic particles of the female semen, is penetrated by the organic particles of the male semen, that an animal is formed. This formation is instantaneous ; but the motions of the new animal are imperceptible till 40 hours after the process of incubation has commenced : He would not have assured us that the heart is first formed, and that the other parts are successively joined to it by juxta-position ; since it is apparent, from the experiments of Malpighius, that the rudiments of all the parts are formed at once, but that they become perceptible only in proportion as they are successively unfolded : Lastly, if he had seen, as Malpighius saw, he would not have positively asserted, that no im-
pression

pression of the male seed remained in the eggs, and that it was only by contagion that they were impregnated, &c.

It is likewise proper to remark, that what Harvey has said concerning the parts of generation of the cock is by no means exact. He affirms, that the cock has no penis capable of entering the vagina of the hen. It is certain, however, that this animal, in place of one penis, has a couple, which both act at the same time; and this action is a vigorous compression, if not an actual copulation *. It is by this double organ that the cock throws his seminal liquor into the uterus of the hen.

Let us now compare Harvey's experiments upon female deer with those of De Graaff upon female rabbits; and, though De Graaff believed, as Harvey did, that all animals proceed from eggs, we shall find a great difference in the manner in which these two anatomists have perceived the first formation, or rather the expansion, of the foetuses of viviparous animals.

After exerting every effort to prove, by arguments drawn from comparative anatomy, that the testicles of viviparous females are true ovaria, Graaff explains the manner in which the eggs are detached from the ovaria, and fall into the *horns* of the uterus. He then relates the remarks he made upon a rabbit which he dissected half an hour after copulation. The horns

of

* See Regn. Graaf, p. 242.

of the uterus, he says, were uncommonly red ; there was no change either in the ovaria, or in the eggs which they contained ; and there was not the least appearance of semen in the vagina, in the uterus, or in the *Fallopian tubes*.

Having dissected another rabbit, six hours after copulation, he observed, that the follicles, or coats, which, in his estimation, contain the eggs in the ovary, were become red ; but he found no male semen either in the ovaria or any where else. Twenty hours after copulation, he dissected a third ; he remarked in one ovary three, and in the other five follicles much altered ; for, instead of being clear and limpid, they had become opaque and reddish. In another, dissected twenty-seven hours after copulation, the horns of the uterus, and the superior canals which terminate in them, were still more red ; and their extremities embraced the ovary on all sides. In another, which was opened forty hours after copulation, he found in one ovary seven, and in the other three follicles changed. Fifty-two hours after copulation, he examined another, and found in one ovary four changed follicles, and one in the other ; and having opened these follicles, he discovered in them a kind of glandulous liquor, with a small cavity in the middle, where he could perceive no fluid, which made him suspect that the transparent liquor usually contained in the follicles, and which, he says, is inclosed in its own membranes, might have

have been discharged by some kind of rupture. He searched for this matter in the canals which terminate in the horns of the uterus, and in the horns themselves ; but he found nothing. He only remarked, that the membranes which line the horns of the uterus were much swelled. In another rabbit, dissected three days after copulation, he observed, that the superior extremity of the canal, which terminates in the horns of the uterus, straitly embraced the ovarium on every side : And, having separated it from the ovarium, he remarked, in the right ovarium, three follicles somewhat larger and harder than usual. After searching, with great care, the canals above mentioned, he discovered, he says, an egg in the right canal, and two more in the right horn of the uterus, so small that they exceeded not mustard seeds. These little eggs had each two membranes, and the internal one was filled with a very limpid liquor. Having examined the other ovarium, he found four changed follicles ; three of them were whiter, and had likewise some limpid liquor in their centres ; but the fourth was of a darker colour, and contained no liquor, which made him suspect that the egg had escaped. He therefore searched the corresponding canal and horn of the uterus ; he found an egg in the superior extremity of the horn, which was exactly similar to those he had discovered in the right horn. He alledges, that the eggs, when they are separated

rated from the ovary, are ten times less than before their separation ; and this difference in size, he imagines, is owing to the eggs, while in the ovary, containing another matter, namely, the glandulous liquor which he remarked in the follicles.

Four days after copulation, he opened another rabbit, and found in one ovary four, and in the other three follicles, void of eggs : In the horns corresponding to the ovaria, he found four eggs on one side, and three in the other. These eggs were larger than those he had discovered three days after copulation. They were nearly of the size of the lead-shot used for shooting small birds ; and he remarked, that, in these eggs, the interior membrane was separated from the exterior, and appeared as if a second egg was contained within the first. In another, dissected five days after copulation, he found five empty follicles in the ovaria, and an equal number of eggs in the uterus, to which they adhered very firmly. These eggs were as large as the shot employed for killing hares ; and the internal membrane was still more apparent than in the last experiment. Having opened another rabbit, six days after copulation, he found in one of the ovaria six empty follicles, but only five eggs in the corresponding horn of the uterus ; and they seemed to be all accumulated into one mass : In the other ovary, he saw four empty follicles, and found but one egg in the corresponding

corresponding horn. These eggs were of the size of the largest fowling shot. Seven days after copulation, our anatominist opened another rabbit, and he found in the ovaria some empty follicles, which were larger, harder, and more red than those he had formerly observed ; and he perceived as many transparent tumors in different parts of the uterus ; and, having opened them, he took out the eggs, which were as large as small *pistol* bullets. The internal membrane was more distinct than formerly ; and within this membrane he saw nothing but a very clear liquor. In another, dissected eight days after copulation, he found in the uterus the tumors or cells which contain the egg ; but they adhered so strongly to the uterus, that he could not detach them. In another, which he opened nine days after copulation, he found the cells containing the eggs greatly enlarged ; and he perceived, in the middle of the liquor inclosed by the internal membrane, a small thin cloud. In another, which he opened ten days after copulation, the small cloud was thicker and darker, and formed an oblong body like a little worm. Lastly, twelve days after copulation, he distinctly perceived the embryo, which, though two days before it was only an oblong body, was now so apparent, that he could distinguish its different members. In the region of the breast, he saw two red and two white points, and, in the abdomen, a mucilaginous reddish substance. Four-

teen days after copulation, the head of the foetus was large and transparent ; the eyes were prominent ; the mouth was open ; the rudiments of the ears appeared ; the back-bone was whitish, and bended towards the sternum ; and small blood-vessels arose from each side of it, the ramifications of which extended along the back as far as the legs : The two red points were considerably enlarged, and appeared like the rudiments of the ventricles of the heart ; on each side of the red points he saw two white ones, which were the rudiments of the lungs. In the abdomen he saw the rudiments of the liver, which was reddish, and a small body twisted like a thread, which was the stomach and intestines. After this, till the 31st day, when the female rabbit brings forth, there was nothing to be remarked but the gradual expansion and growth of the parts which were already formed.

From these experiments, De Graaf concludes, that all viviparous females have eggs ; that these eggs are contained in the ovaria or testicles ; that they cannot be separated till they are fecundated by the semen of the male ; because, says he, the glandulous liquor, by means of which the eggs are enabled to escape from their follicles, is not secreted till after an impregnation by the male. He alledges, that those who imagine they have seen pretty large eggs in three days, have been deceived ; because, in his opinion, the eggs, though fecundated, remain longer in the ovarium,

um, and, in place of augmenting, they become ten times less than formerly, and they never begin to grow till after their descent from the ovaria into the uterus.

By comparing these observations of De Graaff with those of Harvey, we will easily perceive that the latter has missed the principal facts: And, though there are several errors both in the reasoning and in the experiments of De Graaff, this anatomist, as well as Malpighius, have discovered themselves to be better observers than Harvey. They agree in all fundamental points, and both of them contradict Harvey. He perceived not the alterations which take place in the ovaria; he saw not in the uterus those small globules which contain the materials of generation, and which are called eggs by De Graaff. He never suspected that the foetus existed in the egg; and, though his experiments give us tolerably exact ideas concerning what happens during the growth of the foetus, he furnishes no information concerning the commencement of fecundation, nor concerning the first expansion of the foetus. Schrader, a Dutch physician, who had a great veneration for Harvey, acknowledges that he cannot be trusted in many articles, and particularly in what relates to the first formation of the embryo; for the chick really exists in the egg before incubation; and, he says, that Joseph of Arcinatarius was the first who

made this material observation *. Besides, though Harvey alledged that all animals proceeded from eggs, he never imagined that the testicles of females contained eggs ; and it was only from a comparison between the *fac*, which he believed to be formed in the uterus of viviparous animals, with the growth and covering of the eggs in oviparous animals, that he maintained that all animals were produced from eggs ; and even this is but a repetition of what Aristotle had said before him. Steno was the first who pretended to have discovered eggs in the ovaria of females. He says, that, in dissecting a female sea-dog, he perceived eggs in the testicles, though this animal be viviparous ; and he adds, that the testicles of women are analogous to the ovaria of oviparous animals, whether the eggs themselves fall into the uterus, or only the matter which they contain. Steno first discovered these supposed eggs ; De Graaff is willing to assume the discovery to himself ; and Swammerdam warmly disputes the point with him, and alledges that Van-Horn had seen them before De Graaff. This last writer, it is true, has been accused of asserting many things which have been contradicted by experiments : He even pretended, that a certain judgment might be formed of the number of foetuses in the uterus, by the number of cicatrices or empty follicles in the ovaria. In this he is contradicted by the experiments

* See Obs. Justi Schraderi, Amst. 1674.

experiments of Verrheyen *, by those of M. Mery †, and by some of his own, where he found fewer eggs in the uterus, than cicatrices in the ovaria. Besides, we shall demonstrate that what he says concerning the separation of the eggs, and the manner in which they descend into the uterus, is by no means exact ; that no eggs exist in the testicles of females ; that what is seen in the uterus is not an egg ; and that the systems which have been deduced from the observations of this celebrated anatomist are perfectly chimerical.

This pretended discovery of eggs in the testicles of females attracted the attention of most anatomists. They only found, however, in the testicles of viviparous females, small bladders. These they hesitated not to consider as real eggs ; and, therefore, they called the testicles *ovaria*, and the vesicles *eggs*. They asserted also, like De Graaff, that these eggs differed in size in the same ovarium ; that the largest in the ovaria of women exceeded not the bulk of a small pea ; that they are very small in young girls ; but that they increased with age and intercourse with men ; that not above 20 could be reckoned in each ovarium ; that these eggs are fecundated in the ovarium by the spiritous part of the male semen ; that they then separate and fall into the uterus through the Fallopian tubes, where the

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foetus

* Tom. 2. chap. 3. edit. De Bruxelles, 1710.

† Hist. de l'acad. 1701.

foetus is formed of the internal substance of the egg, and the placenta of its external parts ; that the glandulous matter, which exists not in the ovary till after a fruitful embrace, compresses the egg, and excludes it from the ovary, &c. But, though Malpighius, who examined more accurately, detected many errors committed by these anatomists even before they were received ; yet most physicians adopted the opinion of De Graaff, without regarding the observations of Malpighius, which were nevertheless of the greatest importance, and which received much weight from the experiments of his disciple Valisnieri.

Malpighius and Valisnieri, of all naturalists, appear to have written with most judgment and acuteness on the subject of generation. We shall, therefore, give an account of their experiments and remarks.

Malpighius, after examining the testicles of a number of cows and other female animals, assures us, that he found, in the testicles of all of them, vesicles of different sizes, whether the females were very young or adults. These vesicles are enveloped in a pretty thick membrane, the inside of which is interspersed with blood-vessels ; and they are filled with a kind of lymph or liquor, which coagulates and hardens by the heat of a fire, like the white of an egg.

In process of time, a firm yellow body adheres to the testicles. It is prominent, increases to

to the size of a cherry, and occupies the greatest part of the ovary. This body consists of several angular lobes, the position of which is very irregular, and it is covered with a coat or membrane interspersed with nerves and blood-vessels. The form and appearance of this yellow body varies considerably at different times. When it exceeds not the size of a grain of millet, it is roundish, and its substance, when cut, has a warty appearance. We often find an external covering round the vesicles of the ovaria, which consists of the same substance with the yellow bodies.

When the yellow body has become nearly of the size of a pea, it resembles a pear; and, in the centre of it, there is a small cavity filled with liquor. The same thing may be remarked when it is as large as a cherry. In some of these yellow bodies, after they have arrived at full maturity, Malpighius affirms that he saw, towards the centre, a small egg with its appendages, about the size of a millet seed; and, after they had discharged these eggs, they were flaccid and empty. They then resembled a cavernous canal; and the void cavities were as large as peas. He conceived that Nature designed this yellow glandulous body for the preservation of the egg, and for making it escape from the testicles; and that, perhaps, it contributed to the formation of the egg; consequently, he remarks, the vesicles which are at all times found in the

ovarium, and always differ in size, are not the true eggs which receive the impregnation, but serve only to produce the yellow bodies in which the eggs are formed. Besides, though these yellow bodies are not always found in every ovary ; yet we always find the rudiments of them. Malpighius found the marks of them in new born heifers, in cows with calf, and in pregnant women ; and, therefore, he properly concludes, that these yellow glandulous bodies are not, as De Graaff asserts, an effect of impregnation. The yellow bodies, he remarks, produce unfecundated eggs, which fall out of the ovary independent of any communication with the male, and also those which fall after impregnation. When the impregnated eggs fall into the uterus, every thing proceeds in the manner described by De Graaff.

These observations of Malpighius demonstrate, that the testicles of females are not real ovaria ; that the vesicles they contain are not eggs ; that these vesicles never fall into the uterus ; and that the testicles, like those of males, are only reservoirs containing a liquor which may be regarded as female semen in an imperfect state. This semen is matured in the yellow glandulous bodies, of which it fills the internal cavities, and flows out after the yellow bodies have acquired their full size.

But, before we form a judgment concerning this important point, we must attend to the remarks of Valisnieri.

In the year 1692, Valisnieri began his experiments upon the testicles of the sow. The testicles of the sow differ from those of cows, of mares, of sheep, of she-asses, of female-dogs, of she-goats, of women, and of most viviparous animals ; for they resemble a small bunch of raisins, the grains of which are round and prominent on the outside ; between these grains are smaller ones, which have not acquired full maturity. These grains appear not to be covered with a common membrane. They are, says he, analogous to the yellow bodies observed in cows by Malpighius ; they are round, and of a reddish colour ; their surface is interspersed with blood-vessels, like the eggs of viviparous animals ; and the whole grains together form a mass which is larger than the ovary. With a little address, these grains may be separated from the ovary, and each of them, after separation, leaves a notch or depression.

These glandulous bodies are not of the same colour. In some sows they are more red ; in others more clear ; and they are of all sizes, from the smallest seed, to that of a raisin. On opening them, a triangular cavity appears, filled with a limpid liquor, which coagulates with heat, and becomes white, like that which is contained in the vesicles. Valisnieri expected to find the egg in some of these cavities : But in this he was disappointed ; though he made a careful search into all the glandulous bodies of a

number

number of sows, and other animals, he could never discover the egg, which Malpighius affirms he once or twice found.

Under these glandulous bodies, the vesicles of the ovary appeared. They were more or less numerous, according as the glandulous bodies were larger or smaller ; for, in proportion to the largeness of the glandulous bodies, the vesicles diminished. Some vesicles were of the size of a lentil, and others exceeded not that of a millet seed. In the testicles, when raw, from 20 to 35 vesicles might be reckoned ; but, when boiled, a much greater number appear, and they are so firmly attached, that they cannot be separated without breaking some of them.

Having examined the testicles of a young sow, which had never brought forth, he found, as in the others, the glandulous bodies ; and their triangular cavities were likewise filled with lymph ; but he could not discover any eggs either in the one or the other. The vesicles of this young sow were more numerous than in those which had brought forth, or those which were impregnated at the time of examination. In the testicles of another sow, which was far advanced in pregnancy, Valisnieri found two of the largest glandulous bodies, which were flaccid and empty, and others, of a lesser size, in their ordinary state ; and, in several others which he dissected when with young, he remarked, that the number of glandulous bodies was always greater than the number

number of foetuses. This fact confirms what we observed concerning the experiments of De Graaff, and proves that they are by no means exact. What he calls follicles of the ovarium are only the glandulous bodies, the number of which always exceeds that of the foetuses. In the ovaria of a sow, two or three months old, the testicles were pretty large, and interspersed with vesicles of a considerable size. Among the vesicles, the beginnings of four glandulous bodies appeared in one testicle, and of seven in the other.

After these experiments upon sows, Valisnieri repeats those of Malpighius upon cows, and he found them to be exactly conformable to truth. He indeed acknowledges, that he was never able to discover the egg which Malpighius imagined he had seen once or twice in the interior cavities of the glandulous bodies. After a fruitless search in the testicles of so many different females, it was natural to think that Valisnieri would at least have doubted the existence of such eggs. But prejudice in favour of system made him admit, contrary to his own experience, the existence of eggs, which neither he nor any other man ever saw, or ever will see.

It is, perhaps, impossible to make a greater number, or more exact experiments, than those of Valisnieri. Among other animals, he examined the ewe, and found, that she never has more glandulous bodies in her testicles than foetuses

foetuses in the uterus. In young ewes, which were never impregnated, there is but one glandulous body in each testicle, and, when one is emptied, it is succeeded by another; if a ewe has one foetus in the uterus, she has only one glandulous body in her testicles; and if she has two foetuses, she has likewise two glandulous bodies. This glandulous body occupies the greatest part of the testicle; and, after it is emptied and disappears, another begins to grow for the purpose of a future generation.

In the testicles of a she-af, he found vesicles as large as small cherries; which is an evident proof that they are not eggs, as it would be impossible for them to pass, by the Fallopian tubes, into the uterus.

The testicles of female wolves, dogs, and foxes, are covered with a membrane, like a purse, which is an expansion of that which surrounds the *horns* of the uterus. In a bitch which began to be in season, but had not been approached by the male, Valisnieri found the internal part of this purse, which does not adhere to the testicle, moistened with a liquor that resembled whey, and two glandulous bodies in the right testicle, about two lines in diameter, and which occupied nearly the whole extent of the testicle. Each glandulous body had a small nipple, with a distinct fissure, from which, without pressing it, there issued a liquor like clear whey; he therefore concluded, that this liquor was the same

which

which he found in the purse.. He blew into this fissure with a pipe, and the whole glandulous body immediately swelled ; and, having introduced a bristle, he easily penetrated to its bottom. He opened the body on that side where he had introduced the bristle, and found an internal cavity which communicated with the nipple, and contained a considerable quantity of liquor. Valisnieri was always in hopes of discovering the egg ; but these hopes, notwithstanding all his researches, were uniformly frustrated. He likewise found, in the left testicle, two glandulous bodies very similar to those in the right. He boiled two of these glandulous bodies, hoping that, by this means, he might discover the egg ; but still without any measure of success.

Having dissected another bitch four or five days after she had received the male, he found in the testicles three glandulous bodies exactly similar to the former. He searched every where for the egg ; but he was still disappointed. By the assistance of the microscope, he discovered the glandulous bodies to be a net-work, composed of an infinite number of globular vesicles, which served to filtrate the liquor that issued through the nipple.

He then opened another bitch which was not in season, and having tried to introduce air between the testicle and the purse which covered it, he found that it dilated like a bladder filled with air. Having removed the purse, he discovered

vered two glandulous bodies upon the testicles ; but they had neither nipple nor fissure, and no liquor distilled from them.

In another bitch that had brought forth about five whelps two months before, he found five glandulous bodies ; but they were much diminished in size, and they began to disappear, without leaving any cicatrices. There remained only a small cavity in their centre ; but it contained no liquor.

Not satisfied with these, and many other experiments, Valisnieri, who passionately desired to discover this pretended egg, called together the best anatomists his country afforded, and, among others, M. Morgagni ; and, having opened a young bitch that was for the first time in season, and that had been covered three days before, they examined the vesicles of the testicles, the glandulous bodies with their nipples, their canals, and the liquor in their internal cavities ; but they could perceive no eggs. He then, with the same intention, made experiments on sheep-goats, foxes, cats, a number of mice, &c. In the testicles of all these animals, he uniformly found the vesicles, and frequently the glandulous bodies, with the liquor they contained ; but no egg ever appeared.

In fine, being desirous of examining the testicles of women, he had an opportunity of opening a young country-woman, who had been some years married, and who was killed by a fall

fall from a tree. Though of a robust and vigorous constitution, she had never born any children. He endeavoured to discover if the cause of her barrenness existed in the testicles; and he found that the vesicles were all filled with a blackish and corrupted matter.

In a young girl of eighteen years of age, who had been brought up in a convent, and who had every appearance of real virginity, he found the right testicle a little longer than the left: It was of an oval figure, and its surface was somewhat unequal. This inequality was occasioned by five or six vesicles which protruded on the outside of the testicle. One of these vesicles, which was more prominent than the rest, he opened, and a quantity of lymph rushed out. This vesicle was surrounded with a glandulous substance, in the shape of a crescent, and of a reddish yellow colour. He cut the testicle transversely, and found a number of vesicles filled with limpid liquor; and he remarked, that the Fallopian tube of this testicle was redder and somewhat longer than the other, as he had often observed in other animals when they were in season.

The left testicle was whiter, and its surface more smooth; for, though some vesicles were a little prominent, none of them were in the form of nipples; they were all similar to each other, and the corresponding Fallopian tube was neither swelled nor red.

In the body of a girl, aged five years, he found the testicles with their vesicles, their blood-vessels, and their nerves.

In the testicles of a woman of sixty years, he discovered some vesicles, and the vestiges of a glandulous substance, like large points of an obscure yellowish brown colour.

From all these observations, Valisnieri concludes, that the work of generation is carried on in the female testicles, which he continued to regard as ovaria, though he never could find any eggs in them, and though, on the contrary, he had discovered that the vesicles were not eggs. He says, likewise, that, for the impregnation of the egg, it is not necessary that the male semen should enter the uterus. He supposes, that the egg escapes through the nipple of the glandulous body, after being impregnated in the ovary; that it then falls into the Fallopian tube; that it gradually descends, and at last attaches itself to the uterus: He adds, that he is fully persuaded, that the egg is concealed in the cavity of the glandulous body, though neither he nor any other anatomist was ever able to discover it.

In his estimation, the spirit of the male seed ascends into the ovary, penetrates the egg, and gives motion to the foetus which previously existed in the egg. In the ovary of the original mother of mankind, he observes, were eggs, which contained not only all the children she produced, but of the whole human race. If

this

this chain of infinite individuals contained in one be incomprehensible to us, it is entirely owing to the imbecillity of our minds, of which we have daily proofs. But it is not, therefore, less consonant to truth, that all the animals which have existed, or can exist, were created at once, and were all included in their first mothers. The resemblance of children to their parents is owing, he continues, to the imagination, which acts so forcibly on the foetus as to produce stains, monstrosities, disorder of parts, and extraordinary concretions, as well as perfect similarities.

This system of eggs, though it explains nothing, and has no foundation in Nature, would have obtained the universal suffrages of physicians, if, nearly about the same time, another opinion had not sprung up, founded upon the discovery of spermatic animals.

This discovery, which we owe to Leeuwenhoek and Hartsoeker, was confirmed by Andry, Valisnieri, Bourguet, and many other observers. I shall relate what has been advanced concerning those spermatic animals which are found in the semen of all males. Their number is so great, that the semen seems to be entirely composed of them; and Leeuwenhoek pretends to have seen many millions of them in a drop less than the smallest grain of sand. Though none of them appear in females, they are found in the emitted semen of all males, in the testicles, and in the vesiculae seminales. When the semen of

as man is exposed to a moderate heat, it thickens, and the motion of all the animalcules is suddenly stopped. But, when allowed to cool, it dilutes, and the animals continue in motion till the liquor again thickens by evaporating. The more this fluid is diluted, the number of animalcules is augmented; and, when greatly diluted by the addition of water, the whole substance of the fluid seems to be composed of animals. When the motion of the animalcules is about to cease, either on account of heat or of drying, they appear to approach nearer each other, to have a common circular motion in the centre of the small drop under observation, and to perish, all of them, at the same instant. But, when the quantity of liquor is greater, it is easy to distinguish them dying in succession.

These animalcules are said to be of different figures in different animals; but they are all long, thin, without any members, and move with rapidity in every direction. The fluid in which they are contained, as formerly remarked, is much heavier than blood. The semen of a bull, when chemically analysed by Verrheyen, yielded first phlegm, then a considerable quantity of foetid oil, a very small proportion of volatile salt, and more earth than he expected *. This author was surprised that he could draw no spirit from the distillation of semen; and, as he imagined it contained a great quantity of spirits,

* See Verrheyen sup. anat. tom. 2. p. 69.

spirits, he attributed the evaporation of them to their subtility. But may we not suppose, with more probability, that it contains little or no spirits ? Neither the consistence, nor the odour of this fluid, indicate the presence of ardent spirits, which never abound but in fermented liquors ; and, with regard to volatile spirits, the horns, bones, and solid parts of animals, afford more of them than the fluids. What has received the appellation of seminal spirits, *aura seminalis*, among anatomists, has, perhaps, no existence ; and it is certain, that the moving bodies apparent in the seminal fluid are not agitated by these spirits. But, that we may be enabled to pronounce more clearly concerning the nature of the semen, and of its animalcules, we shall present the reader with the principal observations which have been made on the subject.

Leeuwenhoek, having examined the semen of a cock, perceived a number of animals similar to river eels ; but they were so minute, that 50,000 of them were not equal in bulk to a grain of sand. Of those in the semen of a rat, it required, he says, many millions to make the thickness of a hair, &c. This excellent observer was persuaded, that the whole substance of the semen was only a mass of animalcules. He saw these animalcules in the semen of men, of quadrupeds, of birds, of fishes, and of insects. In the semen of a grass-hopper, the animalcules were long, and extremely thin. They appeared,

he says, to be attached by their superior end ; and the other end, which he calls their tail, had a brisk motion, like that of the tail of a serpent when its head is fixed. In the semen of young animals, when examined before they have any sexual appetite, he alledges that he saw the same minute animals, and that they had no motion : But, when the season of love arrived, the animalcules moved with great vivacity.

In the semen of a male frog, he saw animalcules ; but, at first, they were imperfect, and had no motion : Some time after, he found them alive. They were so minute, he observes, that ten thousand of them were only equal in bulk to a single egg of the female.

In the semen of a man and that of a dog, he pretended to see two species of animalcules, resembling males and females. Having shut up the semen of the dog in a small vial, he says, that a great number of animalcules died the first day ; that, on the second and third day, still more of them died ; and that few of them were alive on the fourth day. But, having repeated this experiment on the semen of the same dog, he found, at the end of seven days, the animalcules as brisk and lively as if they had been newly extracted from the animal : And, having opened a bitch that, some time before the experiment, had been three times covered by the same dog, he could not perceive, with his naked eye, any male semen in the uterus or its appendages ; but,

but, by the assistance of the microscope, he found the spermatic animals of the dog in both *horns* of the uterus: In that part of the uterus which is nearest the vagina, he discovered great numbers, which evidently proves, says he, that the male semen enters the uterus, or, at least, that the spermatic animals of the dog had arrived there by their own motion, which enables them to pass over 4 or 5 inches in half an hour. In the uterus of a female rabbit, which had just received the male, he observed an infinite number of spermatic animals. He remarks, that the bodies of these animals are round; that they have long tails; and that they often change their figure, especially when the fluid in which they swim begins to dry up.

These experiments of Leeuwenhoek were repeated by several people, who found them exactly consonant to truth. But Dalenpatius, and some others, who were inclined to exceed Leeuwenhoek in acuteness of vision, alledged that, in the semen of a man, they not only found animals resembling tadpoles, whose bodies appeared to be as large as a grain of corn, with tails about four times as long as their trunks, and which moved with great agility; but, what is still more amazing, Dalenpatius saw one of these animals break through its coat or covering: It was then no more an animalcule, but a real human body, in which he easily distinguished the two arms and legs, the breast and the

head *. But it is apparent, from the very figures given by this author, of the embryo which he pretended to have seen escape from its covering, that the fact is absolutely false. He believed that he saw what he describes ; but he was deceived ; for this embryo, according to his description, was more completely formed, at the time of its transmigration from the condition of a spermatic worm, than it is in the uterus of the mother at the end of the fourth or fifth week. Hence this observation of Dalenpatius, instead of being confirmed by future experiments, has been rejected by all naturalists, the most acute of whom have only been able to discover in the seminal fluid of man round or oblong bodies, which appear to have long tails, but no members of any kind.

One would be tempted to think that Plato had been acquainted with these spermatic animals which are transformed into men ; for, at the end of his *Timaeus* †, he says, ‘ *Vulva quoque matrixque in foeminis eadem ratione animal avidum generandi, quando procul a foetu per aetatis florem, aut ultra diutius detinetur, aegre fert moram ac plurimum indignatur, passimque per corpus oberrans, meatus spiritus intercludit, respirare non finit, extremis vexat angustiis, morbis denique omnibus premit, quo usque utrorumque* ’

* See *nouvelles de la republique des lettres*, ann. 1699, p. 552.

† P. 1088, edit. Ficini.

‘ trorumque cupido amore, quasi ex arboribus
 ‘ foetum fructumve producunt, ipsum deinde de-
 ‘ cerpunt, et in matricem velut agrum inspar-
 ‘ gunt: Hinc animalia primum talia, ut nec prop-
 ‘ ter parvitatem videantur, necdum apparent
 ‘ formata, concipiunt; mox quae conflaverant,
 ‘ explicant, ingentia intus enutriunt, demum e-
 ‘ ducunt in lucem, animaliumque generationem
 ‘ perficiunt.’ Hippocrates, in his treatise *De
 Diaeta*, seems likewise to insinuate that the se-
 men of animals is full of animalcules. Demo-
 critus talks of certain worms which assume the
 human figure; and Aristotle tells us, that the
 first men issued from the earth in the form of
 worms. But neither the authority of Plato, of
 Aristotle, of Hippocrates, of Democritus, nor
 that of Dalenpatius, will ever be able to bestow
 credibility on a notion which is repugnant to the
 repeated experience and observation of all those
 who have hitherto made inquiries into this sub-
 ject.

Valisnieri and Bourguet perceived small
 worms in the semen of a rabbit: One of their
 extremities was longer than the other; they were
 very active in their motions, and beat the fluid
 with their tails: Sometimes they raised them-
 selves to the top of the liquor, and sometimes
 sunk to the bottom; at other times they turned
 round, and twisted like serpents: In fine, says
 Valisnieri, I clearly perceived them to be real
 animals: ‘ E gli riconobbi, e gli gindicai senza
 I. 3. ‘ dubitamento

‘ dubitamento alcuno per veri, verissimi, arcivis-
‘ rissimi vermi *.’ This author, though preju-
diced in favour of the ovular system, admitted
the actual existence of spermatic animals.

M. Andry pretends, that he could find no animals in human semen previous to the age of puberty; that they exist not in the semen of very old men; that there are few of them in those who are affected with the venereal disease, and that these few are in a languishing state; that none of them appear alive in impotent persons; and that the animalcules in the semen of men have a larger head than those of other animals, which corresponds, he observes, with the figure of the foetus and infant; and he adds, that those who use women too frequently have generally few or no animalcules in their semen.

Leeuwenhoek, Andry, and others, exerted every effort against the egg-system: They discovered in the semen of all males living animalcules; they proved that these animalcules could not be regarded simply as inhabitants of this fluid, since the quantity of them was larger than that of the fluid itself; and since nothing similar to them existed either in the blood, or in any other of the animal fluids: They maintained, that, as females furnished no animalcules, their fecundity was solely derived from the males; that the existence of living animals in the semen throws more light upon the nature of generation

* See opere del. Cav. Valisnieri, tom. 2. p. 105.

ration than all the former discoveries on this subject; because the greatest difficulty in generation is to conceive how life is first produced, the future expansion and growth of the parts being only accessory operations; and, consequently, that not a doubt remained of these animalcules being destined to become men, or perfect animals, according to their species. When the improbability was objected to them, that millions of animalcules, all equally capable of becoming men, should be employed for this purpose, while only one of them was to enjoy the singular advantage of being admitted into the condition of humanity; when it was demanded of them, why this useless profusion of human germs was employed? they replied, That it corresponded with the usual magnificence of Nature; that, in plants and trees, millions of seeds were produced, while only a few of them succeeded; and that, therefore, we ought not to be surprised at the prodigious number of spermatic animals. When the extreme minuteness of a spermatic worm, compared with the body of a man, was mentioned to them as a difficulty, they answered, that the seeds of trees, of the elm, for example, were equally minute, when compared with the perfect individuals; and they added, with equal propriety, metaphysical arguments, by which they proved, that largeness and minuteness were only relations, and that the transition from small to great, or from great to small, was performed by

Nature

Nature with greater facility than we could possibly imagine.

Besides, they asked, are there not frequent examples of the transformation of insects? Do we not daily see small aquatic worms, by simply throwing off their skin or covering, from which they received their external figure, transformed into winged animals? May not spermatic animalcules, by a similar transformation, become perfect animals? Every thing, therefore, they conclude, concurs in establishing this system of generation, and in overturning that which is founded on the notion of eggs; and, though eggs really existed in viviparous animals, as well as in the oviparous, these eggs would only be the matter necessary for the growth and expansion of the spermatic worm, which enters by the pedicle which attaches the egg to the ovarium, where it finds abundance of nourishment. All the worms which are so unfortunate as to miss this passage through the pedicle into the egg, perish, and that one alone which finds the proper road is transformed into a perfect animal. The difficulty of finding this passage is sufficient to account for the great number and apparent profusion of the spermatic animals. It is a million to one against any individual worm's finding this passage; but, to compensate this difficulty, there are more than a million of worms. When a worm has once got possession of an egg, no other can enter into

it;

it; because, say they, the first worm shuts up the passage; or rather, there is a valve at the entry to the pedicle, which plays while the egg is not perfectly full; but, when the worm has filled the egg, this valve will not open, though pushed by a second worm. Besides, this valve is exceedingly well contrived; for, if the worm should chance to descend through the passage by which it entered, the valve prevents its escape, and obliges it to remain till it be transformed. The spermatic worm then becomes a real foetus; and it is nourished by the substance of the egg, and the membranes serve it for a covering; and, when the nourishment contained in the egg begins to fail, the foetus attaches itself to the internal surface of the uterus, and, by this means, extracts nourishment from the blood of the mother, till, by its weight, and the increase of its strength, it at last breaks off all connection with the uterus, and issues into the world.

According to this system, it was not the first woman, but the first man, who contained all mankind in his own body. The pre-existent germs are no longer inanimate embryos locked up in eggs, and included, *in infinitum*, within each other. They are, on the contrary, small animals or organized living *homunculi*, included in each other in endless succession, and which, to render them men, or perfect animals, require nothing but expansion, and a transformation similar to that of winged insects.

As

As physicians are at present divided between the system of spermatic worms, and that of eggs, and as every new writer upon generation has adopted either the one or the other of these hypothesis, it is necessary to examine them with care, and to show not only their insufficiency to explain the phaenomena of generation, but that they rest upon suppositions which are entirely destitute of probability.

Both systems suppose an infinite progression, which, as formerly remarked, is a mere illusion of the brain. A spermatic worm is more than a thousand million of times smaller than a man. If, then, the body of a man be taken as an unit, the body of a spermatic worm will be expressed by the fraction $\frac{1}{10000000000}$, *i. e.* by a number consisting of ten cyphers; and, as man is to a spermatic worm of the first generation in the same proportion as this worm is to a worm of the second generation, the size of this last spermatic worm will be expressed by a number consisting of 19 cyphers; for the same reason, the size of a spermatic worm of the third generation must be expressed by a number consisting of 28 cyphers, that of the fourth generation by 37 cyphers, that of the fifth generation by 46 cyphers, and that of the sixth generation by 55 cyphers. To form an idea of the minuteness represented by this fraction, let us take the dimensions of the sphere of the universe from the Sun to Saturn; and, supposing the Sun to be a million

million of times larger than the Earth, and distant from Saturn a thousand solar diameters, we shall find that 45 cyphers are sufficient to express the number of cubic lines contained in this sphere ; and, if we reduce each cubic line into a thousand million of atoms, no more than 54 cyphers will be necessary to express their number: Of course, a man will be proportionally greater, when compared with a spermatic worm of the sixth generation, than the sphere of the universe when compared to the smallest atom that can be seen with the assistance of a microscope. But, if this calculation were carried on to the 16th generation, the minuteness would exceed all powers of expression. It is apparent, therefore, that the probability of this hypothesis vanishes in proportion as the object diminishes. This calculation applies equally to eggs as to spermatic worms ; and the want of probability is common to both. It will, no doubt, be objected, that, as matter is infinitely divisible, this gradual diminution of size is not impossible. To this I reply, that all infinities, whether in geometry or in arithmetic, are only mental abstractions, and have no actual existence in Nature. If the infinite divisibility of matter is to be regarded as an absolute infinite, it is easy to demonstrate, that, in this sense, it has no existence ; for, if we once suppose the smallest possible atom, by the very supposition, this atom must be indivisible ; because, if it were divisible,

it would not be the smallest possible atom, which is contrary to the supposition. It is, therefore, apparent, that every hypothesis which admits an infinite progression ought to be rejected not only as false, but as destitute of every vestige of probability; and, as both the vermicular and ovular systems suppose such a progression, they should be excluded for ever from philosophy.

These systems are liable to another objection: In the ovular system, the first woman contained both male and female eggs; the male eggs could only give origin to males; but the female eggs must have contained millions of generations of both males and females: Hence every woman must have always contained a certain number of eggs capable of being unfolded *in infinitum*, and another number, which could only be unfolded once, and could have no farther operation in the series of existence. The same thing must take place in the vermicular system. Hence we may conclude, that there is not the smallest degree of probability in hypotheses of this nature.

A third difficulty still remains, arising from the resemblance of children sometimes to the father, sometimes to the mother, and sometimes to both, and from the evident characters of specific differences in mules and other monstrous productions. If the foetus proceeds from the spermatic worm of the father, how comes the child to resemble its mother? If the foetus pre-
exists

exists in the egg of the mother, how should the child resemble its father ? And, if the spermatic worm of a horse, or the egg of a she-afs, be the origin of the foetus, how should the mule partake of the nature and figure both of the horse and ass ?

These general objections, though perfectly invincible, are not the only difficulties with which both systems are embarrassed. May it not be demanded of those who embrace the vermicular system, how these worms are transformed, and wherein consists the analogy between this transformation and that which insects undergo ? The caterpillar which is to become a butterfly, passes through a middle state, and, after it ceases to be a chrysalis, is completely formed, has acquired its full growth, and is instantly capable of generating : But, in the pretended transformation of the spermatic worm of a man, there is no middle or chrysalis state ; and, supposing it should happen during the first days of conception, why is not the production of this chrysalis, in place of an unformed embryo, a perfect adult ? Here all analogy ceases ; and, of course, the notion of the transformation of the spermatic worm can receive no support from this quarter.

Besides, the worm which is to be transformed into a fly proceeds from an egg ; this egg is impregnated by the copulation of the male and female, and it includes the foetus which is to pass into

into a chrysalis, before it arrives at the perfect state of a fly, and before it acquires the power of generating. But the spermatic worm has no generative faculty ; neither does it proceed from an egg : And, though it should be supposed that the semen contains eggs which produce the spermatic animals, the same difficulty still remains ; for these supposed eggs are not a result of the copulation of two sexes, like those of insects. Consequently, the analogy fails here likewise ; and the transformation of insects, in place of strengthening this hypothesis, seems to destroy it entirely.

The seeds of vegetables are resorted to, in order to account for the infinite number of spermatic animals ; But this analogy does not apply ; for all the spermatic animals, one only excepted, must absolutely perish. The seeds of vegetables, however, are not subject to the same necessity. When they become not vegetables themselves, they nourish other organized bodies, and serve the purposes of growth and of reproduction to animals. But the prodigious superfluity of spermatic animals can answer no end whatever. I make this remark, purely because I wish to omit nothing that has been advanced on the subject ; for I acknowledge, that no argument drawn from final causes can either establish or destroy a physical theory.

The apparent equality in the number of spermatic animalcules in all animals, has also been objected

objected to by the supporters of this doctrine. If these animalcules are the immediate cause of generation, why is there no proportion between their numbers and those of the young, which are various in men, quadrupeds, birds, fishes, and insects? Besides, there is no proportional difference in most species of spermatic animals, those of a rat being nearly equal in size to those of a man. Even when a difference in size takes place, it has no proportion to the bulk of the animals. The spermatic animals of the calmar, which is a small fish, are a hundred thousand times larger than those of a man or of a dog. This is an additional proof that these worms are not the sole and immediate cause of generation.

The particular objections to the ovular system are not less weighty. If the foetus existed in the egg before the junction of the male and female, why do we not see the foetus in the egg before impregnation, as clearly as after it? We formerly mentioned, that Malpighius always found the foetus in eggs which had received the impregnation of the male, and could discover nothing but an unformed mole or mass in the cicatrice of unimpregnated eggs. It is, therefore, evident, that the foetus is never formed till the egg has been impregnated.

Farther, we not only cannot discover the foetus in eggs before the intercourse of the sexes, but we have not been able to demonstrate the
existence

existence of eggs in viviparous animals. Those physicians who pretend that the spermatic worm is the foetus inclosed in a coat or covering, are at least ascertained of the existence of spermatic worms; but those who maintain that the foetus pre-exists in the egg, have no evidence of the existence of the egg itself; for the probability of the non-existence of eggs in viviparous animals amounts almost to a certainty.

Though the partizans of the ovular system agree not as to what ought to be regarded as the real egg in the testicles of females, they all allow, however, that impregnation is accomplished in the testicles or ovary. But they never consider, that, if this were the case, most foetuses would be found in the abdomen instead of the uterus; for, as the superior extremity of the Fallopian tube is unconnected with the ovary, the pretended eggs would often fall into the abdomen. Now, we know this to be at least a very rare phenomenon; and it is probable that it never happens but by means of some violent accident.

These objections and difficulties have not escaped the ingenious author of *Venus Physique*. But, as his work is in the hands of the public, and as it admits not of abridgement, we shall refer the reader to the book itself; and shall conclude with an account of a few particular experiments, some of which appeared to favour and others to contradict the above systems.

In

In the history of the Academy of Sciences, ann. 1701, some objections are proposed by M. Mery against the egg-system. This able anatomist maintained, with propriety, that the vesicles found in the testicles of females are not eggs; that they adhere so firmly to the internal surface of the testicle, as not to admit of a natural separation; and that, though they could separate from the substance of the testicle, it was impossible for them to get out of it, because the texture of the common membrane inclosing the whole testicle is so firm and strong, that it is impracticable to conceive the possibility of its being pierced by a vesicle, or round soft egg. And, as most anatomists and physicians were prepossessed in favour of the egg-system, and imagined that the number of cicatrices in the testicles corresponded with the number of foetuses, M. Mery showed such a quantity of these cicatrices in the testicles of a woman, as, upon the supposition of the truth of this system, would have argued a fecundity beyond the power of credibility. These difficulties stimulated other anatomists of the Academy, who were partizans of the eggs, to make new researches. M. Duverney examined the testicles of cows and sheep, and maintained, that the vesicles were eggs, because some of them adhered less firmly to the testicles than others; and that it was natural to suppose they separated altogether when they arrived at full maturity; especially as, by blowing into

the cavity of the testicle, the air passed between the vesicles and the adjacent parts. M. Mery simply replied, that this proof was insufficient, as these vesicles were never seen separate from the testicles. M. Duverney farther observed the glandulous bodies upon the testicles ; but he never considered them as parts essential to generation, but as accidental excrescences, like gall-nuts on the oak. M. Littre, whose prejudices in favour of eggs were still stronger, maintained not only that the vesicles were eggs, but even assured us, that he discovered in one of them a well formed foetus, of which he could distinguish both the head and trunk ; and he has even given their dimensions. But, admitting this wonder, which never appeared to any eyes except his own, to be convinced of the doubtfulness of the fact, we have only to peruse his memoir*. From his own description, it appears that the uterus was schirrous, and the testicle very much corrupted ; that the vesicle or egg, which contained the pretended foetus, was much less than common, &c.

Nuck furnishes us with a celebrated experiment in favour of eggs. He opened a bitch three days after copulation ; he drew out one of the *horns* of the uterus, and tied it in the middle, so as to prevent the superior part of the Fallopian tube from having any communication with the inferior. After this, he replaced the

horn

* Année 1701, p. 111.

horn of the uterus, and closed the wound. Twenty-four hours afterwards, he again opened the wound, and found two foetuses in the superior part of the tube, that is, between the testicles and the ligature; and there was no foetus in the under part. In the other horn of the uterus that was not tied, he found three foetuses, regularly disposed; which proves, says he, that the foetus proceeds not from the male semen, but that it exists in the egg of the female. Supposing this experiment, which is single, had been often repeated with the same success, the conclusion the author draws from it is not legitimate: It proves no more than that the foetus may be formed in the superior part of the horn of the uterus, as well as in the inferior; and it is natural to think that, by the pressure of the ligature, the seminal liquor in the inferior part was forced out, and, of course, frustrated the work of generation in that region of the uterus.

This is all the length that anatomists and physicians have proceeded in the subject of generation. It only remains that I deliver the results of my own experiments and inquiries; and I shall leave the reader to judge whether my system be not infinitely more consonant to Nature than any of those which I have enumerated.

Experiments on Generation.

I Often reflected on the above two systems of generation, and was daily more and more convinced that my theory was infinitely more probable. At length I began to suspect that those living organic particles, from which I thought all animals and vegetables derived their origin, might be recognized by the assistance of good glasses. My first notion was, that the spermatic animalcules found in the seminal fluid of all males, might probably be those very organic particles ; and I reasoned in this manner. If all animals and vegetables contain an infinite number of organic particles, these particles should be most abundant in their seeds, because the seed is an extract from all the organic parts, and especially from those which are most analogous to the individual : Perhaps the spermatic animals found in the semen of males may actually be those very organic particles, or, at least, the first union or assemblages of them. But, if this be the case, then the semen of females ought to contain organic living particles, or animalcules, similar to those

those of the male. They ought, for the same reason, to be found in the seeds of plants, in the nectarium, and in the stamina, which are the most essential parts of vegetables, and contain the organic particles necessary for their reproduction. I therefore determined to examine with the microscope the seminal liquors of males and females, and the germs of plants; and, at the same time, I imagined that the cavities of the glandulous bodies of the uterus might be the reservoirs of the female semen. Having communicated my ideas of this subject to my ingenious friends Mr Needham, M. Daubenton, M. Gueneau, and M. Dalibard, they encouraged me to commence a set of experiments in order to throw light upon this mysterious operation of Nature. All of these gentlemen occasionally attended and assisted me; but particularly M. Daubenton, who was never absent, and who was witness to every experiment I made.

I employed a double microscope, which I had from Mr Needham, being the same with which he made his numerous and ingenious observations *. This instrument is infinitely preferable to those employed by Leeuwenhoek †.

K 3

EXPERI-

* Published in the year 1745.

† Here M. de Buffon mentions the advantages of the double microscope, and some precautions necessary in the management of it, which, now that the instrument is well known, and much improved since the author wrote, it is unnecessary to translate.

E X P E R I M E N T I.

Having procured the seminal vessels of a man who died a violent death, and whose body was still warm, I extracted all the liquor from them, and put it in a vial. I examined, by the microscope, a drop of this liquor, without any dilution. As soon as the vapours, which arose from the liquor, and obscured the glass, were dissipated, I observed pretty large filaments [plate III. fig. 1.], which, in some places, spread out into branches, and, in others, intermingled with each other. These filaments clearly appeared to be agitated with an internal undulatory motion, like hollow tubes, which contained some moving substance. I saw distinctly [pl. III. fig. 2.] two of these filaments, which were joined longitudinally, separate from each other in the middle, and alternately approach and recede, like two stretched cords, fixed by the ends, and drawn asunder at the middle. These filaments were composed of globules which touched one another, and resembled a chaplet of beads. I then observed filaments [pl. III. fig. 3.] which were blown up, and swelled in certain places, and perceived small oval globules issue from these swelled parts, which had a vibratory motion, like that of a pendulum [pl. III. fig. 4.] These small bodies were attached to the filaments by little threads, which

which gradually lengthened as the bodies moved: And, lastly, I observed these small bodies detach themselves entirely from the large filament, and draw after them the little thread, which resembled a tail. As the liquor was too thick, and the filaments too near each other, I diluted another drop with pure rain water, after satisfying myself that it contained no animalcules. I then perceived that the filaments were more distant from each other, and saw distinctly the motion of the small bodies above taken notice of, [pl. III. fig. 5.] which was more free, and they appeared to swim with greater agility, and trailed their threads after them with greater ease; and, if I had not seen them separate from the filaments, and draw the threads out of them, I should have believed, from this second observation, the moving bodies to be real animals, and their threads to be tails. After examining with great attention one of the filaments, which was three times thicker than the small bodies, I perceived two of these bodies detach themselves with much difficulty, and drag after them long slender threads, which impeded their motion.

This seminal liquor was at first too thick: But it gradually became more fluid, and, in less than an hour, it was almost transparent; and, in proportion as its fluidity augmented, the phenomena changed, in the manner to be just mentioned.

EXPER.

EXPER. II.

When the seminal liquor became more fluid, the filaments disappeared; but the small bodies were exceedingly numerous [pl. III. fig. 6.]. Their motion, for the most part, resembled that of a pendulum; each of them had a long thread, from which they evidently endeavoured to disengage themselves; their progressive motion was extremely slow, during which they vibrated to the right and left. At each vibration, they had a rolling unsteady motion; so that, besides their horizontal vibrations, they roll or vibrate in a verticle direction; which proves these bodies to be of a globular figure, or at least that their inferior part is not a flat base sufficiently extensive to keep them in one position.

EXPER. III.

At the end of two or three hours, when the liquor was more fluid, a still greater number of these moving bodies appeared [pl. IV. fig. 7.]. They were more free of incumbrances; their threads were shorter; their progressive motion was more direct; and their horizontal vibration was greatly diminished; for the longer the threads were, their vibratory motion was increased,

fed, and their progress forward was diminished. The vertical vibration was still apparent.

E X P E R. IV.

In five or six hours, the liquor had almost all the fluidity it could acquire, without being decomposed. We then discovered [pl. IV. fig. 8.] that most of these small moving bodies were entirely disengaged from their threads. Their figure was oval: They moved forward with considerable quickness; and by their motion backward and forward, and to every side, they had now more than ever the appearance of real animals. Those which had tails or threads sticking to them, seemed to have less vivacity than the others. Of those which had no threads, some appeared to change both their figure and their size. Some were round; but the greatest part of them were oval, and a few were thicker at the extremities than in the middle. The rolling and vibratory motions were still perceptible.

E X P E R. V.

In 12 hours, the liquor had deposited, at the bottom of the vial, a kind of gelatinous, bluish, or rather ash-coloured substance; and the fluid that

that swummed on the top was nearly as clear as water, only it had a tincture of blue, like water in which a small quantity of soap has been dissolved. It still, however, retained its viscosity. The little bodies, which were now entirely freed from their threads, moved with gread activity on all sides, and some of them turned round their centres. Most of them were oval, though some of them were round. I have seen them change figures, and from oval become round: I have seen them divide, and, from a single oval or globule, separate into two. Their activity always increased as their size diminished.

EXPER. VI.

At the end of 24 hours, the liquor had deposited a greater quantity of gelatinous matter, which I diluted, with some difficulty, in water. It appeared to consist of a multitude of opaque tubes resembling lace, but without any regularity or the smallest motion. In the clear semen itself, there were a few small bodies still moving; next day their number was still farther diminished. After this, nothing was to be seen but globules without the least appearance of motion.

These experiments were often repeated with great exactness; and they convinced me that the threads which adhere to the moving bodies are not tails, nor any part proper to these bodies; for

Plate 3.

Fig. 1.

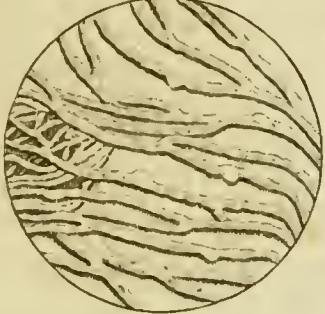


Fig. 2.

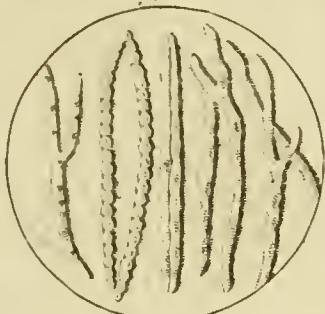


Fig. 3.

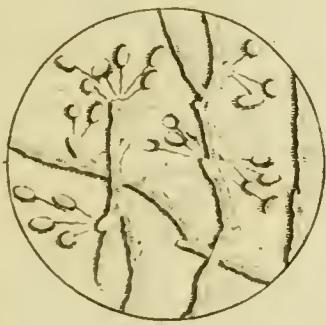


Fig. 4.



Fig. 5.

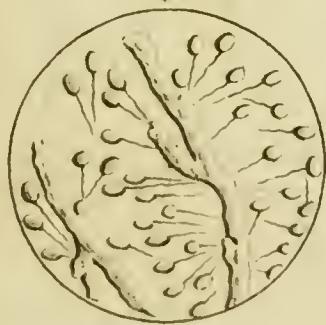
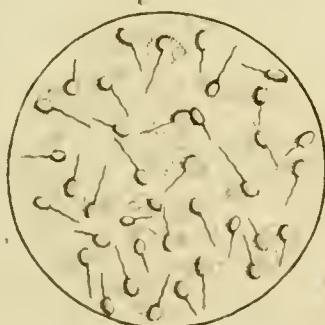
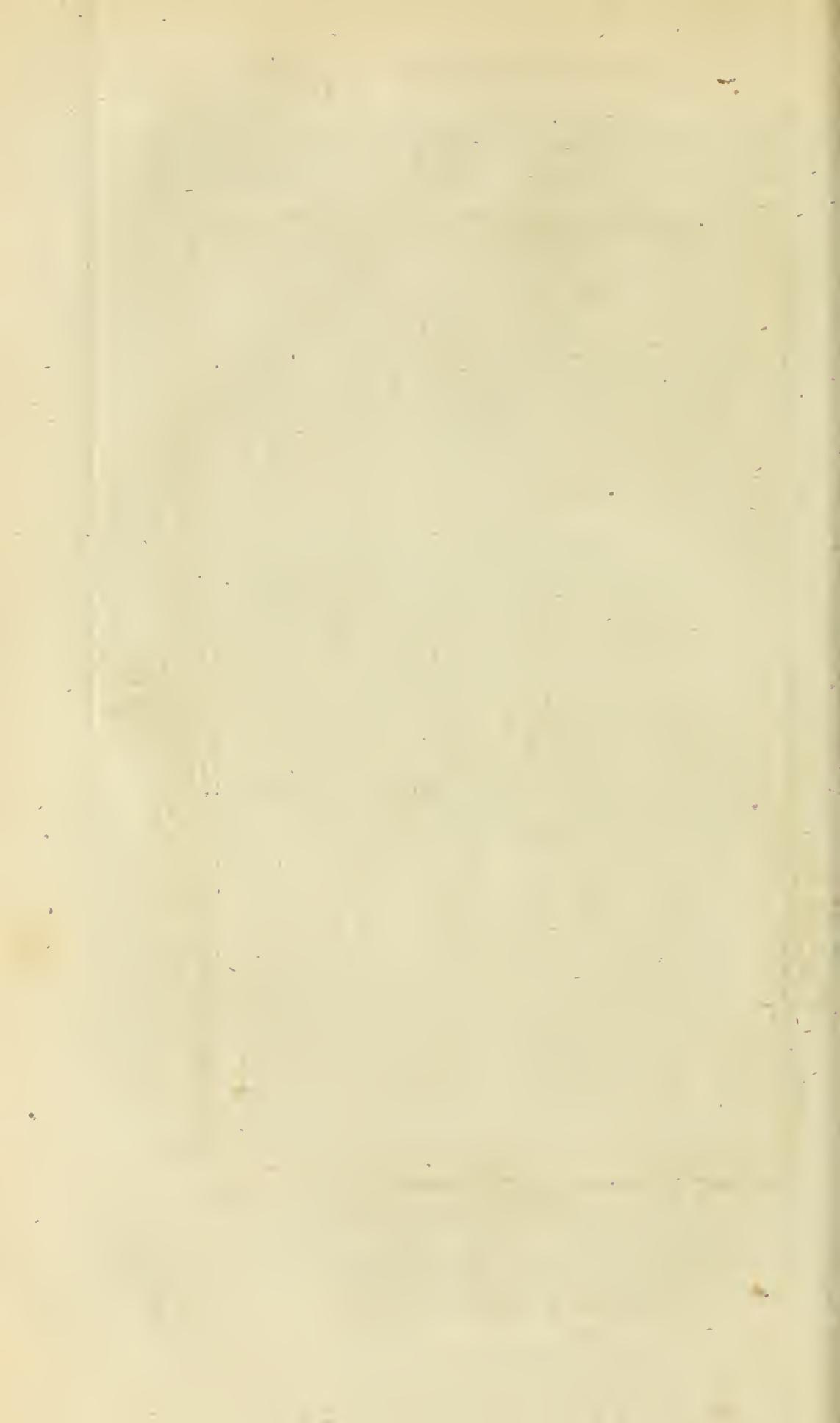


Fig. 6.





for the tails or threads have no proportion to the rest of the body; they are of different dimensions, though the bodies are always nearly of the same size at the same time. The motion of the globule is embarrassed in proportion to the length of the tail. When the tail is too long, it sometimes prevents the progressive motion altogether, leaving nothing but the vibrations from right to left; and the globules make evident efforts to disentangle themselves from this incumbrance.

E X P E R. VII.

Having procured the seminal fluid of another man recently dead, I put a pretty large drop of it on the glass, which soon liquified without any mixture. It had the appearance of a close network, the filaments of which were of a considerable length and thickness, and they seemed to proceed from the thickest part of the liquor, [pl. IV. fig. 9.]. These filaments separated in proportion as the liquor became more fluid; and at last they divided into globules, which seemed at first to have too little force to put them in motion: But their power of moving increased as they receded from the filaments, and they appeared to make considerable efforts to disengage themselves. In this manner each of them gradually drew tails of different lengths out of the filaments.

filaments. Some of these tails were so long and so thin, that they had no proportion to the bodies, which were always more or less embarrassed, according to the length of the threads or tails. When the tail was long, the angle of the vibratory motion was increased; and, when the tail was short, the progressive motion was more conspicuous.

E X P E R. VIII.

I continued my observations, almost without interruption, for 14 hours, and I discovered, that the length of the tails or threads gradually diminished, and became so thin and delicate, that their extremities successively ceased to be visible; and at last the whole disappeared. The horizontal vibrations of the globules then ceased, and their progressive motion was direct, though they still had verticle oscillations, or rather, they rolled like a vessel at sea. The small bodies, when deprived of their tails, were oval and transparent, and resembled those pretended animals which are seen in oyster water on the 6th or 7th day, or those found in the jelly of roasted veal at the end of the 4th day.

E X P E R. IX.

Between the 10th and 12th hour, the liquor was become very fluid, and all the globules appeared

peared to proceed in troops from one side of the drop [pl. IV. fig. 10.]. They passed over the field of the microscope in less than four seconds; they marched in lines of seven or eight in front; and succeeded each other without interruption, like the desiling of soldiers. I observed this singular phaenomenon for more than five minutes; and, as the current of animals did not then cease, I was desirous of discovering the cause. I therefore gently shifted the glass, and perceived that all these moving globules proceeded from a kind of mucilage, [pl. IV. fig. 11.] or net-work of filaments, which continually produced them, and with more rapidity and copiousness than the filaments had done ten hours before. There was still a difference more remarkable between the globules produced by the liquor, when thick, and those produced when it was more fluid; for, in the latter case, they drew no threads or tails after them, their motion was quicker, and they went in flocks like sheep. I examined the mucilage from which they proceeded for a long time, and perceived that it gradually diminished and was converted into moving globules, till more than one half of it was destroyed. After which, the liquor being too dry, this mucilage became obscure in the middle, and it was surrounded with small threads, forming square intervals, [pl. IV. fig. 12.]. These small threads seemed to be composed of the bodies of the moving globules which had been killed by the drying of the

the liquor, and the whole resembled the web of a spider besprinkled with drops of dew.

E X P E R. X.

By the first experiments, I perceived that these small moving bodies changed their figures ; and I imagined, that, in general, they diminished in bulk, though I was not then altogether certain of the fact. But my subsequent observations removed every doubt. At the 12th. and 13th hour, the bodies were visibly smaller ; but, as they diminished in bulk, their specific gravity increased, especially when they ceased to move, which they generally did all at once, and fell down to the bottom in the form of an ash-coloured sediment, which was perceptible by the naked eye ; and, by the assistance of the microscope, it appeared to be composed of globules attached to one another, sometimes by threads, and at other times in groups, but always in a regular manner.

E X P E R. XI.

Having procured the fresh semen of a dog, I observed that this liquor was clear, and had very little tenacity. I examined it without the addition of water, and I perceived moving bodies almost

Plate 4.

Fig. 8.

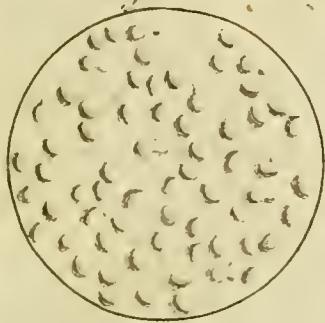


Fig. 7.

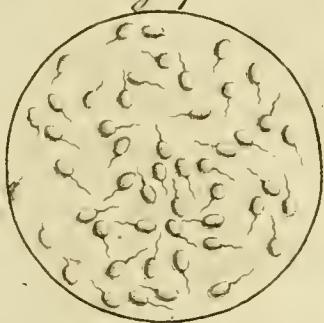


Fig. 10.

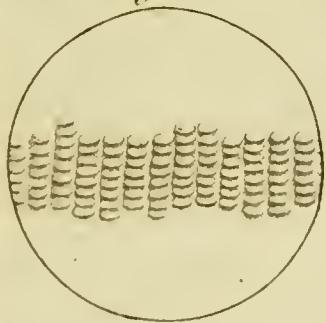


Fig. 9.

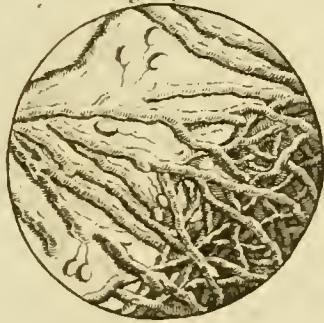


Fig. 12.

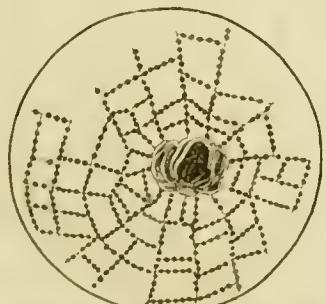
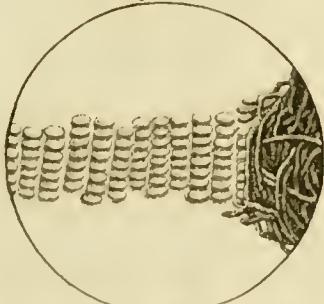


Fig. 11.



almost entirely similar to those in the human semen, [pl. V. fig. 13.]. Their tails and their form were almost precisely the same with those represented in pl. IV. fig. 7. where the liquor had been liquified for two or three hours. I in vain searched this liquor for the filaments which appeared in that of men. I only remarked some long and very delicate threads, exactly similar to those which served for tails to the globules. These threads contained no globules; neither had they any motion. The globules with tails seemed to move with more vivacity than those in the human semen. They had hardly any horizontal vibrations; but they always rolled vertically. Their number was not great; and, though their progressive motion was quicker, they took up some time in passing over the field of the microscope. I examined this liquor during three hours, and could observe no change. I continued my examination, from time to time, for several days, and remarked, that the number of moving bodies gradually diminished. On the second day, the greatest part of them had lost their tails: On the third, very few of them retained their tails; on the fourth, however, some tails still adhered. The liquor had now deposited a whitish sediment, which appeared to be composed of globules without motion, and some small threads that seemed to be the tails which had separated from the globules. Some globules appeared to have dead ones attached to them;

them ; for their figure differed from that of those in motion, [pl. V. fig. 14.] : They were larger than the moving globules, or the dead ones at the bottom of the liquor, and seemed to have a kind of fissure or opening.

E X P E R. XII.

At another time I examined the seminal fluid of the same dog, and perceived the same phenomena which have been described. I farther observed, in a drop of this liquor, a mucilaginous part, [pl. V. fig. 15.] from which globules issued as in Exper. IX. and these globules formed a current, and moved in regular troops. This mucilage appeared to be agitated internally with a swelling or undulating motion, which produced small protuberances in different parts ; and these protuberances issued suddenly in the form of globules, which moved briskly forward in the same direction. These globules differed not from the others, except that they issued from the mucilage without tails. Some of them, I remarked, changed their figure ; they lengthened themselves till they resembled small cylinders ; after which the extremities of the cylinders swelled, and divided by the middle into two globules, and both of them moved on in the same direction with the rest.

E X P E R.

E X P E R. XIII.

The small glass which contained this liquor having been overturned by accident, I took, from the same dog, another quantity of semen. But, whether the animal had been fatigued by too frequent emissions, or from some other cause, this seminal liquor contained nothing: It was transparent and viscous, like the serum of blood; and, though I examined it, at different times, for 24 hours, I could perceive no moving bodies, no mucilage, nor, in a word, any thing similar to what I had formerly seen.

E X P E R. XIV.

I then opened a dog, and took out the testicles, and the vessels adhering to them; but I remarked, that he had no seminal vessels: The semen of this animal probably passes directly from the testicles into the urethra. Though the dog was full grown and vigorous, I found very little semen in the testicles. I examined with the microscope the small quantity I could collect; but could perceive no moving bodies: I saw only a great number of very minute globules, the greatest part of which were motionless; and some of the smallest of them seemed to move towards each other. But of this I could not be

certain; because the small drops dried in a minute or two after they were put upon the glass.

E X P E R. XV.

I cut the testicles of this dog into two parts, put them into a glass-vessel, with as much water as was sufficient to cover them, and corked up the glass. Three days after, I examined this infusion with a view to discover if the flesh contained any moving bodies, and I perceived in the water of this infusion a great number of moving bodies, some of them of a globular, others of an oval figure, and entirely resembling those I had seen in the seminal fluid of the former dog, except that they had no threads or tails: They moved in all directions with great vivacity. I observed, during a long time, these bodies, which appeared to be animated, and I perceived several of them change their figures before my eyes. Some of them lengthened, others contracted, and others swelled at the two extremities. The whole of them seemed to turn on their centres; some of them were larger, and others smaller; but the whole were in motion, and resembled, both in size and figure, those which were described in Exper. IV.

E X P E R.

E X P E R. XVI.

Next day, the number of moving globules was still increased; but they were smaller; their motion more rapid and more irregular; and their form and manner of moving were different, and appeared to be more confused: The day after, and the following days, till the 20th, moving bodies still appeared in this water. They daily diminished in size, and at last became so small that they could hardly be perceived; but the last of them I was able to distinguish on the 18th and 20th days, moved with the same rapidity as ever. On the top of the water there was a pellicle which appeared to be composed of the skins or coverings of the moving bodies, of small threads, &c. But no motion appeared in it. This pellicle and the moving bodies could not be introduced into the liquor by means of the external air; for the bottle was always closely corked.

E X P E R. XVII.

I opened successively, on different days, ten rabbits, in order to examine their seminal fluid. In the first, second, and third, I found not a single drop, either in the testicles or seminal vessels, though I was certain that two of them were

fathers of a numerous progeny. I imagined that the presence of the female might be necessary for the secretion of the semen; I therefore put males and females by pairs into separate cages, so constructed that they could not possibly copulate. Neither did this scheme at first succeed; for I opened two of them without finding any semen. In the sixth, however, which was a large white rabbit, full of vigour, I found as much liquor in the seminal vessels as would fill a small coffee-spoon. This matter resembled the jelly of meat, was of a citron colour, and almost transparent. Having examined it with the microscope, it gradually separated into filaments and large globules, several of which were attached to each other like a string of beads; but I could discover no distinct motion; only, as the matter dissolved, it formed a kind of current, by which the filaments and globules were carried down to one side of the glass. I waited till the matter should become more fluid; but I was disappointed; for, after liquifying a little, it dried up, and I could observe nothing farther than what I have already described. I then added water to it, but without success; for the water seemed not to penetrate or dilute the matter.

EXPER. XVIII.

I opened another rabbit, and found only a small quantity of seminal matter, which had hardly any

any of the yellow colour, and was more fluid than the former. As the quantity was very small, I was apprehensive lest it should dry too suddenly ; I therefore instantly mixed it with water, and could perceive in it neither the filaments nor the strings of beads that I had observed in the other ; but I discovered the large globules, and farther remarked, that they had a kind of trembling restless motion. They had also a progressive motion ; but it was very slow : Some of them moved round others, and most of them appeared to turn round their centres. I could proceed no farther in my observations, because the liquor dried suddenly up.

EXPER. XIX.

Having dissected another rabbit that had been placed in the same circumstances, I found no seminal liquor ; but, in the seminal vessels of another, I found nearly as much congealed matter as in Exper. XVII. I examined this matter without discovering any thing. I therefore took the whole, and, adding to it a double quantity of water, shook the mixture violently in a glass. I then left it to settle for ten minutes ; after which I examined a drop taken from the surface, and perceived the large globules formerly mentioned ; but they were few in number, and perfectly detached from one another. They moved

towards each other ; but this motion was so slow, as to be hardly perceptible. Two or three hours after, the globules seemed to be diminished in size ; their motion was more sensible ; and they turned upon their centres. Though their trembling was more apparent than their progressive motion ; yet they plainly changed places in an irregular manner, with respect to each other. In six or seven hours, the globules were become smaller, and their activity was greater. Their number appeared to be great, and all their motions were sensible. Next day there was a prodigious multitude of moving globules, and they were at least three times smaller than at first. I continued my observations for eight days, and I perceived that several of the globules joined ; and, though all motion ceased after this union, it appeared to be superficial and accidental only. Some of them were larger, and others less ; though most of them were spherical, some were oval, and others cylindrical. The largest were most transparent ; and the smallest were almost black. This difference could proceed from no accident in the light ; for they were always of the same colour, whatever was their situation : The motion of the small globules was likewise more rapid. The whole gradually diminished in size ; so that, on the eighth day, they were so small, that it was with the utmost difficulty I could distinguish them, and at last they totally disappeared.

E X P E R. XX.

In fine, having, with great difficulty, procured the seminal liquor of another rabbit, in the very state in which it is conveyed into the female, I remarked, that it was much more fluid than that which was extracted from the seminal vessels; and the phaenomena it presented were also very different: For, in this liquor there were moving globules, filaments without motion, and a kind of globules with tails or threads, similar to those in the seminal fluid of man and of the dog, only these last appeared to be less, and more active [Pl. V. fig. 17.]. They traversed, in an instant, the field of the microscope: Their tails seemed to be much shorter than those of other spermatic animals; and I acknowledge, that I was uncertain whether some of these tails were not deceptions occasioned by the track of the globules in the liquor; for they moved with such rapidity, that I could hardly observe them; and besides, the liquor, though sufficiently fluid, dried very suddenly.

E X P E R. XXI.

Having procured, at different times, the testicles and seminal vessels of 12 or 13 rams, recently after they were killed, I could not find, either

either in the epididymis or seminal vessels, a quantity of semen sufficient for observation. In the small drops I could collect, I found nothing but globules without motion. As these experiments were made in March, I imagined that, by repeating them in October, which is the time of rutting, I might find more liquor in the vessels. I cut several testicles in two longitudinally, and having collected a small drop of liquor, I still could perceive nothing but motionless globules of different sizes.

E X P E R. XXII.

I took three testicles of three different rams, cut them into four parts, and put each of them into a glass-vessel, with as much water as was sufficient to cover them, and then shut the vessels so close as to exclude the air. I allowed the testicles to infuse during four days; after which I examined the liquor in each glass with the microscope, and found the whole full of moving bodies; most of which were oval, and some of them globular. They were equally large, and greatly resembled those described in Exper. VIII. Their motion was not rapid, but equal, uniform, and in all directions. In each liquor, the moving bodies were nearly of the same size; but, in the one they were larger, in the other less, and, in the third, still more minute: They had no tails;

tails ; neither were there, in the liquor, any threads or filaments. They often changed their figures, and seemed successively to cast their skin or outer covering. They daily became smaller, and, on the 16th day, they were so small as scarcely to be visible.

E X P E R. XXIII.-

In the following October, I opened a ram, and found a great quantity of seminal liquor in the epididymis. Having examined it with the microscope, I saw such an innumerable multitude of moving bodies, that the liquor seemed to be entirely composed of them. As the liquor was too thick, I diluted it with water ; but I was astonished to find, that the water had stopped all motion in the bodies ; though I saw them distinctly in the liquor, they were all at absolute rest. Having frequently repeated the same experiment, I discovered, that cold water, which diluted the seminal liquors of other animals, made that of the ram coagulate.

E X P E R. XXIV.

I then opened another ram, and, to prevent the liquor from coagulating by cold, I left the parts of generation in the body of the animal, which

which was covered with warm cloths. This precaution afforded me an opportunity of examining with ease the seminal liquor of many rams in its fluid state. It was filled with an infinite number of oblong moving bodies, [p. V. fig. 18.] which ran about in every direction. But, whenever the liquor cooled, all motion instantly ceased ; so that I could never observe the same drop above a minute or two. When I diluted the liquor with warm water, the bodies continued to move for three or four minutes. The moving bodies were so numerous, that, though the liquor was diluted, almost all of them touched each other. They were all of the same size and figure. None of them had tails. Their motion was not rapid ; and, when the liquor began to coagulate, they suffered no change in their form.

E X P E R. XXV.

As I was persuaded, both by my theory, and the experiments made by others upon this subject, that the female, as well as the male, possessed a prolific seminal fluid ; and, as I had no doubt but that the glandulous bodies of the testicles, where prejudiced anatomists had in vain searched for the egg, were the reservoirs of this fluid ; I purchased several dogs and bitches, and male and female rabbits, which were kept separate

rate from each other: And that I might have an object to compare with the female fluid, I again examined the seminal liquor of a dog, which had been emitted in the natural manner. I found the moving bodies in the same state, and attended with the same circumstances as formerly [pl. VI. fig. 19.].

E X P E R. XXVI.

A live bitch was next dissected, which had been four or five days in season, without having any communication with the male. The testicles were as large as filberds. On one of them I found a red prominent glandulous body of the size of a pea, which had a perfect resemblance to a little nipple, with a visible fissure, that had two lips, one of which was more prominent than the other. Having opened this fissure, a liquor distilled from it, which we collected for examination. The testicles were then returned into the body of the animal, which was still alive, in order to preserve them from cooling. I then examined this liquor with the microscope, and had the satisfaction of perceiving, at the first glance, moving bodies with tails, exactly similar to those which we had observed in the seminal fluid of the dog [pl. VI. fig. 20.]. Messrs Needham and Daubenton, who were present, were so struck with this resemblance, that they could not be

be persuaded that the spermatic animals were not the very same ; and they imagined that I had forgotten to change the object-glass, or rather, that the same pick-tooth with which the drops of the female fluid were collected, had also been employed in collecting those of the male. Mr Needham, therefore, changed both the object-glass and the pick-tooth, and took a fresh drop from the fissure of the glandulous body, and examined it first with his own eyes. He again saw the very same moving bodies, and was fully convinced, not only of the existence of spermatic animals in the seminal fluid of the female, but also of their resemblance to those in the semen of the male. We repeated the experiment with fresh drops no less than ten times, in all of which the phaenomena were exactly the same.

E X P E R. XXVII.

Having then examined the other testicle, I found an unripe glandulous body, which was smaller, and less red than the former, and had no fissure ; but, after opening it with a scalpel, I found no liquor. Upon the external surface of this testicle, there were some lymphatic vesicles. I pierced one of them with a lancet, and there issued a clear liquor, to which I immediately applied the microscope. But it contained nothing similar to what we discovered in that

Plate V.

Fig. 13.

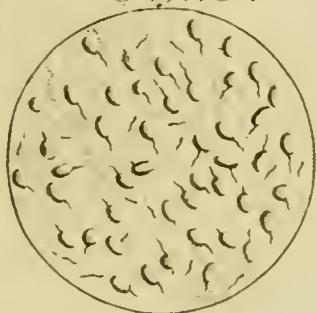


Fig. 14.

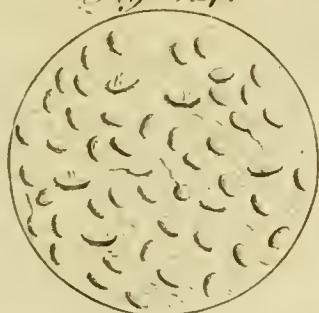


Fig. 15.

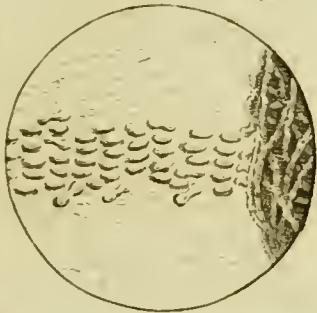


Fig. 16.

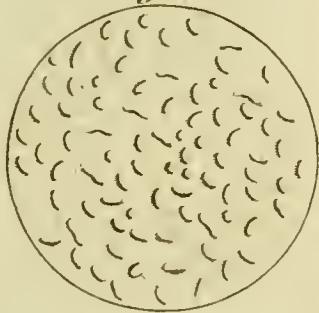


Fig. 17.

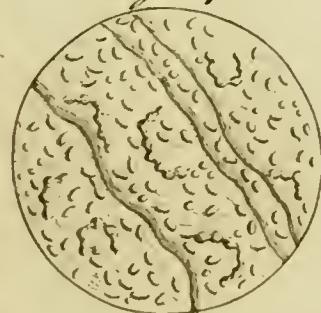
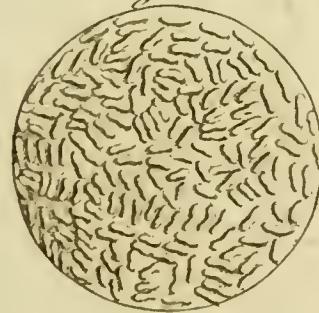
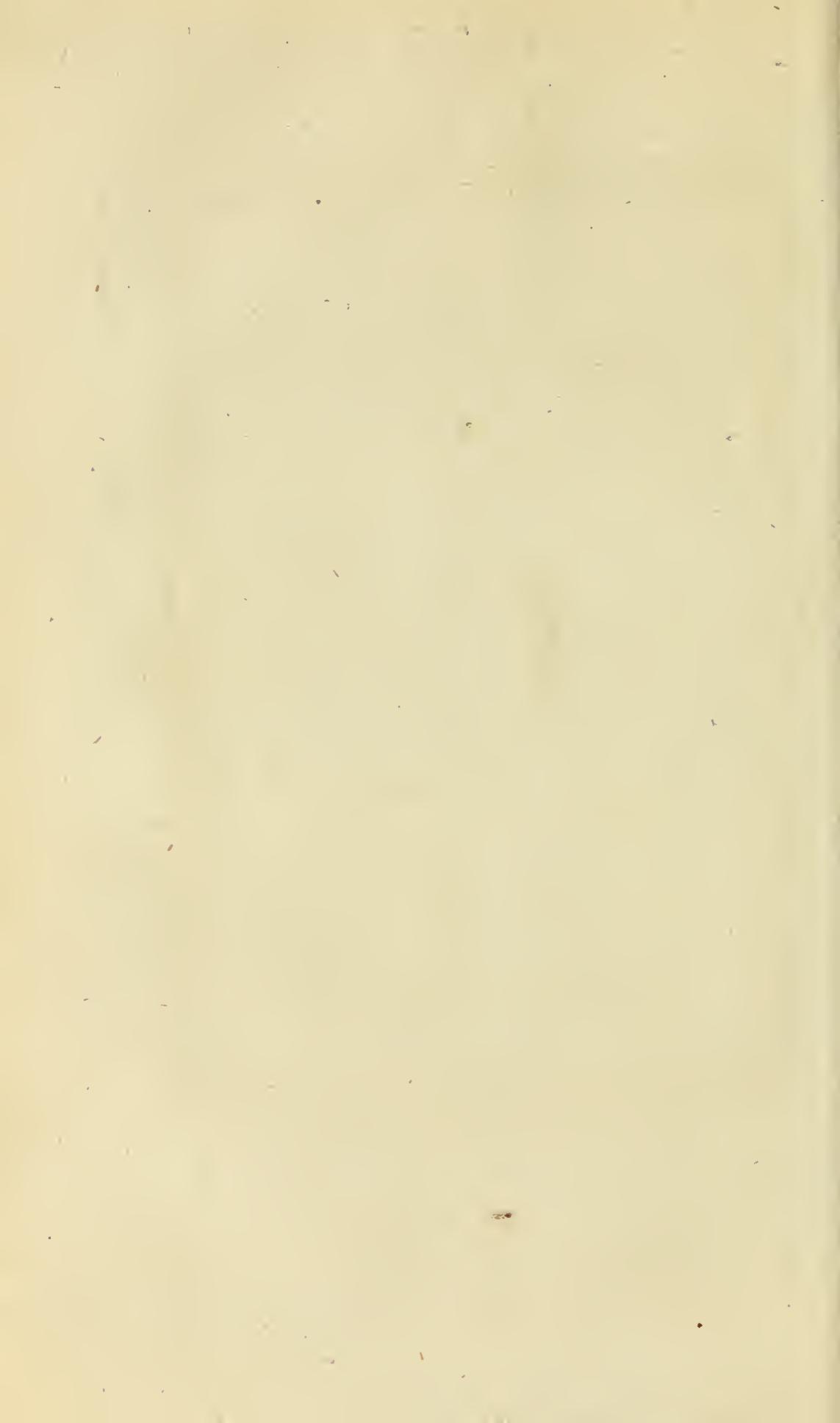


Fig. 18.



A. Bell. Sculp.



that of the glandulous body. It was a transparent liquor, composed of very small globules, without any motion. After repeating this experiment several times, I was convinced; that the liquor in the vesicles is only a species of lymph, which contains nothing animated or similar to what we perceive in the female semen, which is secreted and matured in the glandulous bodies.

E X P E R. XXVIII.

Some time after, another bitch was opened, which had been seven or eight days in season, and had not received the male. I examined the testicles, and upon each I found a glandulous body in full perfection. The first was half open, and had a canal which penetrated the testicle, and was full of seminal fluid; the second was larger and more prominent, and the fissure or canal that contained the fluid was below the nipple, which protruded outward. I took the liquor out of both the glandulous bodies, and, on comparison, found them entirely similar. This seminal liquor of the female is equally fluid with that of the male. After examining the liquors extracted from each testicle, I found in them the very same moving bodies [pl. VI. fig. 21.]. I perceived at leisure the same phaenomena that I had observed in the seminal liquor of the other bitch; I saw several globules which moved with great

great rapidity, which endeavoured to disengage themselves from the mucilage that surrounded them, and which dragged tails or threads after them. Their number was equally great with that in the male semen.

EXPER. XXIX.

I squeezed the whole liquor out of these two glandulous bodies, and put it into the glass of a watch. The quantity was sufficient to serve for four or five hours observation. I remarked that it deposited a kind of sediment, or at least began to thicken. I took a drop of the thickest part of the liquor, and having examined it, I discovered that the mucilaginous part of the semen was condensed, and formed a kind of net-work. From the anterior edge of this net-work, there issued a current of globules which moved with great rapidity [pl. VI. fig. 22.]. These globules were extremely active and lively, and they appeared to be divested of their mucilaginous coverings and of their tails. This stream of globules resembled the motion of the blood in the veins ; for they seemed not only to be animated, but to be pushed on by some common force, which obliged them to follow each other in troops or rows. From this experiment, and from the 11th and 12th, I concluded, that, when the fluid begins to coagulate or grow thick, the active

tive globules break their mucilaginous covering, and escape at that side where the liquor is most fluid. They had no threads or tails, and most of them were oval, and seemed to be flat below; for they had no rolling motion.

E X P E R. XXX.

I opened the horns of the uterus longitudinally, and having squeezed a little liquor out of them, I found it exhibited precisely the same phaenomena with that obtained from the glandulous bodies. These glandulous bodies are so situated, that they can easily pour their liquor upon the horns of the uterus: And I am persuaded that, during the whole season of love, there is a perpetual distillation of this liquor from the glandulous bodies into the horns of the uterus; that this distillation continues till the glandulous bodies be entirely emptied; and that they are gradually effaced, leaving only behind them a small reddish cicatrice on the external surface of the testicle.

E X P E R. XXXI.

I mixed the seminal liquor of the female with an equal portion of that of the male, which was recently emitted; but the moving bodies, and every circumstance, were so entirely the same, that

that I could make no distinction between those of the male and those of the female.

EXPER. XXXII.

Having dissected a young bitch that had never been in season, I discovered on one of the testicles only, a small solid protuberance, which I imagined to be the rudiments of a glandulous body. The surface of the testicles was smooth and uniform, and it was with difficulty I could see the lymphatic vesicles, till the membranes which cover the testicles were removed. The small quantity of liquor that was squeezed from the testicles contained no moving bodies.

EXPER. XXXIII.

In another bitch still younger, there was no appearance of glandulous bodies on the testicles; their surface was white and perfectly smooth. Some small vesicles were discovered; but they seemed to contain no liquor. I compared these female testicles with those of a male of the same age, and found that their internal texture, which was fleshy, was nearly of the same nature.

EXPER.

EXPER. XXXIV.

I procured the uterus of a cow that had been recently killed. It was brought to me in a basket, wrapped in warm cloths, along with a live rabbit, to preserve it from cooling. The testicles were as large as a small hen's egg; on one of them was a glandulous body of the size of a pea, which protruded from the testicle like a little nipple: But it had no fissure or external aperture. It was so firm and hard, that I could press no liquor out of it with my fingers. Before cutting this testicle, I observed two other glandulous bodies at a distance from each other: They were very small, and of a whitish yellow colour; but the large one, which seemed to have pierced the membrane of the testicle, was as red as a rose. I examined this last with great attention, but could discover no liquor; from which I concluded, that it was still far from being mature,

EXPER. XXXV.

In the other testicle, there were no glandulous bodies which had yet pierced the membrane that covers the testicle. Two small ones only began to appear under the membrane. I opened them both; but procured no liquor from them. They were hard bodies, with a tincture of yellow.

On each testicle there were four or five lymphatic vesicles; they were full of liquor. When examined with the microscope, some small globules appeared; but there was not in them the least vestige of motion. I observed this liquor, from time to time, for two days, without discovering any thing new.

EXPER. XXXVI.

I had two other uteri conveyed to me in the same manner. The one belonged to a young cow, that had never brought forth; the other to a cow which, though not old, had had several young. I first examined the testicles of the latter, and found, upon one of them, a glandulous body as large as a cherry. I perceived three holes into which bristles might be introduced. Having pressed the body with my fingers, a small quantity of liquor issued out, which I examined, and had the pleasure of seeing moving bodies, [pl. VI. fig. 22.], but different from what I had observed in other seminal fluids. These globules were small and obscure: Their progressive motion, though distinct, was very slow. The liquor was not thick: The moving globules had no appearance of threads or tails, and they were not all in motion. These are all the observations I could make on this liquor; for, though I again squeezed the glandulous body, I could

could not obtain any more liquor that was unmixed with blood. The moving bodies were at least a fourth part less than the globules of the blood.

EXPER. XXXVII.

This glandulous body was situated at one extremity of the testicle, near the horn of the uterus; and the liquor which it distilled must have fallen upon that horn: But, after opening the horn, I found no liquor. I then opened the testicle longitudinally, and, though its cavity was considerable, it contained no fluid. At some distance from the large glandulous body, there was a small one of the same kind, about the size of a lentil. Two cicatrices, or little pits, also appeared; they were of a deep red colour, and were the relicks of old glandulous bodies which had been obliterated. Having next examined the other testicle of the same cow, I discovered four cicatrices and three glandulous bodies, the most advanced of which was of a red flesh-colour, and exceeded not the size of a pea. It was solid, without any aperture, and contained no liquor. The other two were much smaller and harder; and their colour was a kind of orange. The lymphatic vesicles were full of a clear liquid; but contained nothing that had the appearance of life.

E X P E R. XXXVIII.

I then inspected the testicles of the young cow, which had never brought forth. They were rather larger than those of the other cow; but, what is not less remarkable than true, there was not a single cicatrice on either of them. A number of lymphatic vesicles appeared on one of the testicles; but there was no vestige of glandulous bodies. Upon the other testicle, I could discern the rudiments of two glandulous bodies, one just beginning to spring up, the other as large as a small pea. There were also many vesicles, which appeared, after being pierced with a lancet, to contain nothing. The glandulous bodies, when opened, gave forth nothing but blood.

E X P E R. XXXIX.

I cut each testicle of both cows into four parts, and, having put them into separate vials, I poured as much water upon them as was just sufficient to cover them; and, after corking the vials close, I allowed them to infuse for six days. I then examined the infusions with the microscope, and saw an amazing number of moving globules, [pl. VI. fig. 23.]. In all the infusions, the globules were extremely small, but very active,

active, moving with rapidity round their centres, and in all directions. I observed them, from time to time, during three days, and they always became smaller and smaller, till they totally disappeared on the third day.

E X P E R. XL.

I procured the uteri of three other cows. I first searched the testicles, in order to discover if there were any mature glandulous bodies. In two of the uteri I found only small glandulous bodies on the testicles. I was not informed whether the cows had ever brought forth; but it is probable that they had often been in season; for a number of cicatrices appeared on their testicles. On one of the testicles of the third cow, I observed a glandulous body as large as a cherry, and very red; it was much swelled, and seemed to be perfectly ripe. I pressed the nipple, which was perforated by a hole, with my fingers, and a considerable quantity of liquor issued out. In this liquor, I found moving bodies [Pl. VI. fig. 24.] perfectly similar to those described in Exper. XXXVI. Their number was indeed greater, and their progressive motion was quicker; they seemed to be somewhat longer; and, having observed them a long time, I perceived that they grew longer, and changed their figure. I then introduced a fine probe into the small

aperture of the glandulous body ; and, having cut along the probe as a directory, I found that the cavity was filled with a liquid matter. This liquor, when examined with the microscope, presented the same phaenomena, the same moving bodies, as in Exper. XXXVI. But I could discover in none of them either filaments or tails. The liquor of the vesicles was still transparent, and contained nothing like life or motion.

E X P E R. XLI.

The uteri of several other cows were brought to me at different times. In the testicles of some of them, there were glandulous bodies almost ripe ; in those of others, they were in different states of growth ; and I perceived nothing new or uncommon, except that I discovered, in the testicles of two of them, glandulous bodies in a decayed state, the base of one of which was as large as the circumference of a cherry. The extremity of the nipple was soft and withered : The two small holes through which the fluid had issued were still visible. I introduced a small bristle into them ; but there was no liquor either in the canal, or in the internal cavity, which could still be distinguished. The extinction of the glandulous bodies, therefore, commences at the most external part, or extremity of the nipple. They first diminish in height, and then

in

Plate VI.

Fig. 19.

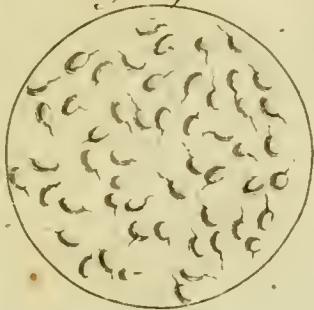


Fig. 20.

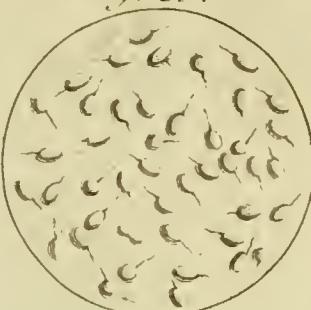


Fig. 21.

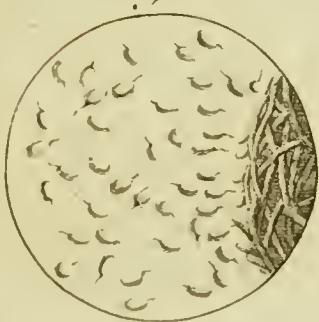


Fig. 22.

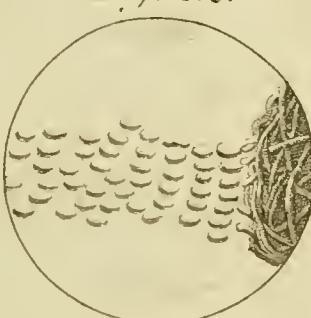


Fig. 23.

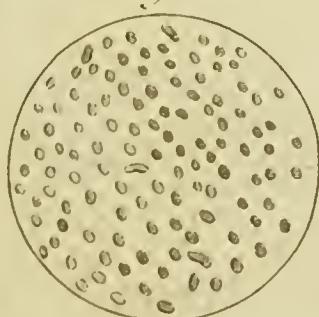
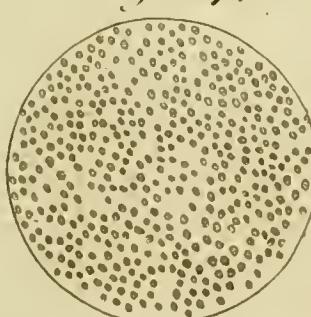
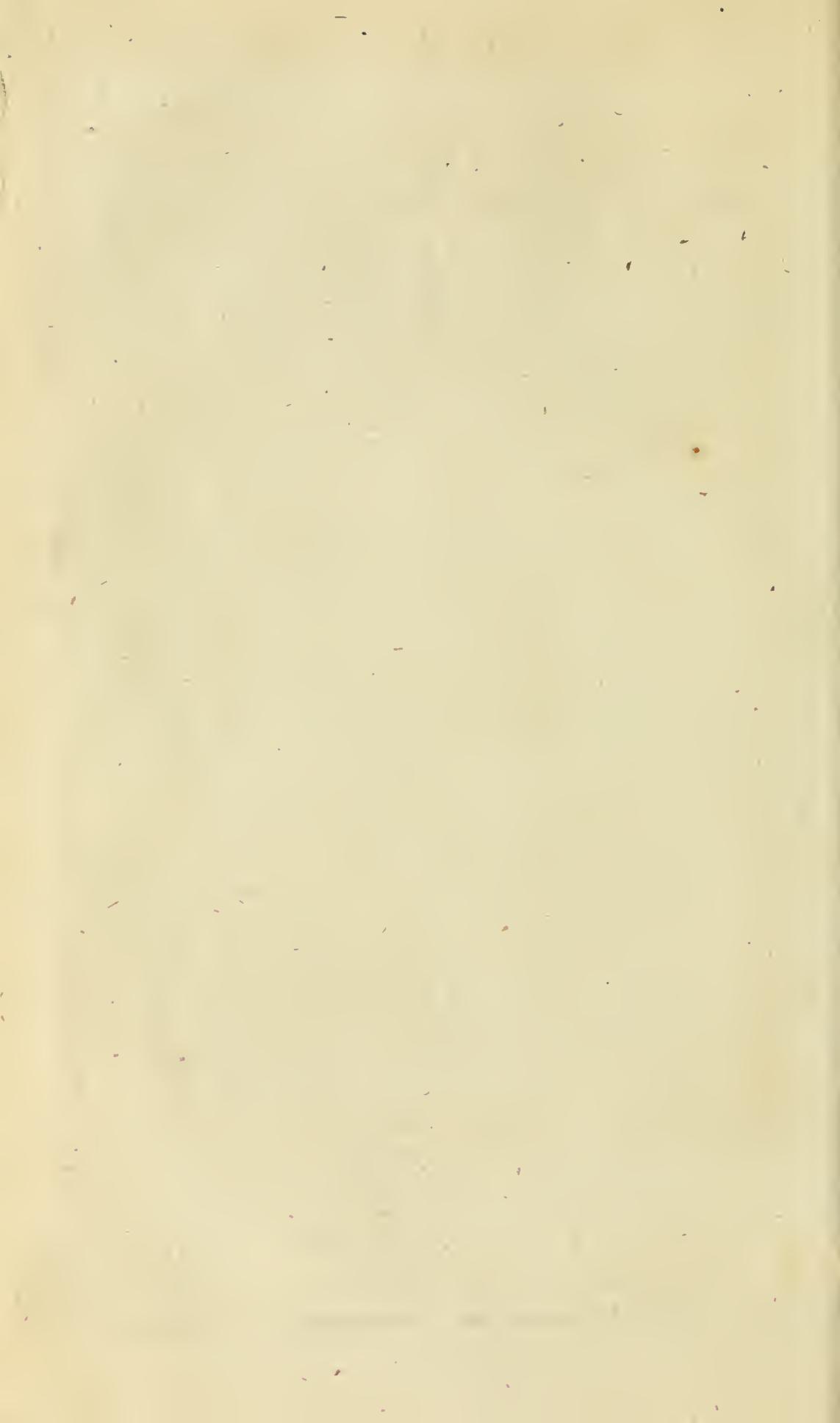


Fig. 24.



Abellatulpi?



in breadth, as I had an oportunity of observing in another testicle, where there was a glandulous body diminished about three fourths.

E X P E R. XLII.

As the testicles of female rabbits, as well as their glandulous bodies, are very minute, I could make no exact experiments on their seminal liquor. I only discovered, that the testicles of different females are in different states; and, that I never saw any of them which exactly resembled De Graaff's figures.

E X P E R. XLIII.

On the testicles of some cows, I found a species of bladders or vesicles, which are called *hydatides* by anatomists. I observed some of them large and others small; and they were attached to the testicle by a kind of pedicle. I examined the liquor they contained; but it was transparent, homogeneous, and every way similar to the liquor in the vesicles. It had no globular or moving particles.

E X P E R. XLIV.

At this time, I made some experiments upon oyster-water, upon water in which pepper had been

been boiled, upon water in which pepper had been simply infused, and upon water in which pink-seeds were infused. The bottles containing all these infusions were exactly corked. At the end of two days, I saw, in the oyster-water, a vast quantity of oval and globular bodies, which seemed to swim like fishes in a pond, and had every appearance of being real animals. They had no members that could be discovered, and no tails. They were transparent, and pretty large; I saw them change their figures; they became gradually smaller and smaller during the seven or eight days that they existed; and, lastly, along with Mr Needham, I saw animalcules so very similar, in an infusion of the jelly of roasted veal, which had likewise been close corked, that I am persuaded they are not true animals, agreeable to the common acceptation of that term, as shall afterwards be fully explained.

The infusion of pink-seeds was crowded with innumerable moving globules, which appeared to be equally animated with those in the seminal liquors and infusions of flesh. At first they were pretty large, and moved with great rapidity in every possible direction. They continued in this state during three weeks, and gradually diminished in size till their minuteness rendered them invisible.

The same phenomenon took place in the infusions of pepper; but the moving bodies did not

not appear so early as in the other infusions, and their appearance was later in the infusion of pepper that was not boiled. I then began to suspect that what is called fermentation, might be owing to the motion of these organic particles in animal and vegetable substances. To discover if there was any similarity between this species of fermentation, and that excited by mineral substances, I applied to the microscope a little limestone powder, and poured upon it a drop of aquafortis. But the phaenomena were totally different. Large bubbles rose to the surface, and instantly darkened the lens of the microscope ; when the gross parts were dissolved, every thing remained at rest, and nothing appeared which had the smallest analogy to what we perceive in the infusions of animal or vegetable substances.

E X P E R. XLV.

I examined the seminal liquor in the milts of different fishes, extracted while the animals were alive ; and I observed a vast quantity of obscure moving globules. I then squeezed with my fingers the aperture in the bellies of fishes through which they emit this liquor ; and, in the drops which I procured, I saw great multitudes of the same moving globules, which were almost black, and very small.

E X P E R.

EXPER. XLVI.

Before I conclude this chapter, I shall relate the experiments of Mr Needham upon the semen of a species of cuttle-fish, called the *Calmar*. This acute observer, having examined the spermatic animals in the milts of different fishes, found them of an uncommon magnitude in the milt of the calmar. To the naked eye, they were from three to four lines in length. During a whole summer, while he dissected calmars at Lisbon, he could find no appearance of a milt, or of any reservoir destined to receive the seminal liquor of that fish ; and it was the middle of December before he could perceive the first vestiges of a new vessel filled with a milty juice. This reservoir, and the juice it contained, gradually increased. In examining this seminal liquor with the microscope, he saw nothing in it but small opaque globules swimming in a kind of serous matter, without any appearance of life. But, some time after, he discovered, in the milt of another calmar, organic bodies completely formed, which resembled spiral springs, [a, b, Pl. VII. fig. 2.] inclosed in a transparent case. These springs were equally perfect at the first observation as afterwards ; only they, in time, contracted themselves, and formed a kind of screw. The head of the case is a species of valve which

which opens outward, and through which every thing within may be forced out. It contains, besides, another valve, *b*, a little barrel, *c*, and a spongy substance, *d, e*. Thus the whole machine consists of an outer, transparent, cartilaginous case, *a*, *fig. 2.* the superior extremity of which is terminated by a round head, formed by the case itself, and performs the office of a valve. This external case contains a transparent tube, which includes the spring, a piston or valve, a little barrel, and a spongy substance. The screw occupies the superior part of the tube and case; the piston and barrel are situated in the middle; and the spongy substance occupies the inferior part. These machines pump the liquor of the milt; the spongy substance is full of this liquor; and, before the animal spawns, the whole milt is only a congeries of these organic bodies, which have absolutely pumped up and dried the milky liquor. Whenever these small machines are taken from the body of the animal, and put among water, or exposed to the air, they begin to act [Pl. VII. *fig. 2.* and *3.*]; the spring mounts up, and is followed by the piston, the barrel, and the spongy substance which contains the liquor: And, as soon as the spring and the tube in which it is contained begin to issue out of the case, the spring plaits, and the whole internal apparatus moves, till the spring, the piston, and the barrel have entirely escaped from the case. When this is effected, all the rest instantly follow, and the

the milty liquor, which had been pumped, and was confined in the spongy substance, runs out through the barrel.

As this phaenomenon is extremely singular, and incontestibly proves that the moving bodies in the milt of the calmar are not real animals, but simple machines, a species of pumps, I shall here transcribe Mr Needham's own account of the matter :

‘ When the small machines *,’ says he, ‘ have come to their full maturity, several of them act as soon as they are exposed to the air. Most of them, however, may be commodiously viewed by the microscope before their action commences ; and, even before they act, it is necessary to moisten with a drop of water the superior extremity of the external case, which then begins to expand, while the two slender ligaments that issue out of the case are twisted and contorted in different ways. At the same time, the screw rises slowly, and the spirals at its superior end approach each other, and act against the top of the case, those which are lower seeming to be continually followed by others that issue from the piston ; I say, that they *seem* to follow ; because I believe it to be only a deception produced by the motion of the screw. The piston and barrel likewise move in the same direction ; and the inferior part,

* Needham's New Discoveries made with the Microscope, ch. 6. p. 53.

part, which contains the semen, extends in length, and, at the same time, moves towards the top of the case, which is apparent by the vacuity left at the bottom. As soon as the screw, with the tube in which it is inclosed, begins to appear out of the case, it twists, because it is constrained by the two ligaments. The whole internal apparatus continues to move gradually and slowly till the screw, the piston, and the barrel, have entirely escaped. When that happens, the remainder issues instantaneously. The piston, *b*, [pl. VII. fig. 2.] separates from the barrel *a*; the ligament, which is under the barrel, swells and acquires a diameter equal to that of the spongy part which succeeds it: This, though much broader than when in the case, becomes also five times longer than formerly. The tube, which included the whole, contracts in the middle, and forms two knots or joints, *d*, *e*, [pl. VII. fig. 2. and 3.], distant about one third of its length from each extremity. Then the semen escapes by the barrel *e*, [fig. 2.]. It is composed of small opaque globules, which swim in a serous matter, without discovering any signs of life, and are precisely the same as I perceived them to be when diffused through the reservoir of the milt. In the figure, the part comprehended between the two joints *d*, *e*, appears to be fringed. When examined attentively, this appearance seems to be occasioned by the spon-

gy

‘ gy substance within the tube being broken and
 ‘ divided into portions nearly equal. The fol-
 ‘ lowing phaenomena will clearly prove that
 ‘ this is the case.

‘ It sometimes happens, that the screw and
 ‘ the tube break precisely above the piston *b*,
 ‘ which remains in the barrel *e*, [fig. 3.] Then
 ‘ the tube instantly shuts; and, by contracting,
 ‘ assumes a conical figure above the extremity of
 ‘ the screw, *f*. This is a demonstration that it
 ‘ is there very elastic; and the manner in which
 ‘ it accommodates its figure to that of the sub-
 ‘ stance which inculudes it, when the latter un-
 ‘ dergoes the smallest change, proves that it is
 ‘ every where equally elastic.’

M. Needham hence concludes, that it is natural to imagine that the total action of this machine is occasioned by the spring of the screw. But, unfortunately, he proves, by several experiments, that the screw is acted upon by a power residing in the spongy part: As soon as the screw is separated from the rest of the machine, it ceases to act, and loses all motion. The author draws the following conclusion from this singular phaenomenon.

‘ If I had seen,’ says he, ‘ these pretended ani-
 ‘ mæcules in the seimen of living animals, I should,
 ‘ perhaps, have been able to ascertain whether
 ‘ they are really animated beings, or only pro-
 ‘ digiously small machines, which correspond in
 ‘ miniature to the larger vessels of the calmar.’

From

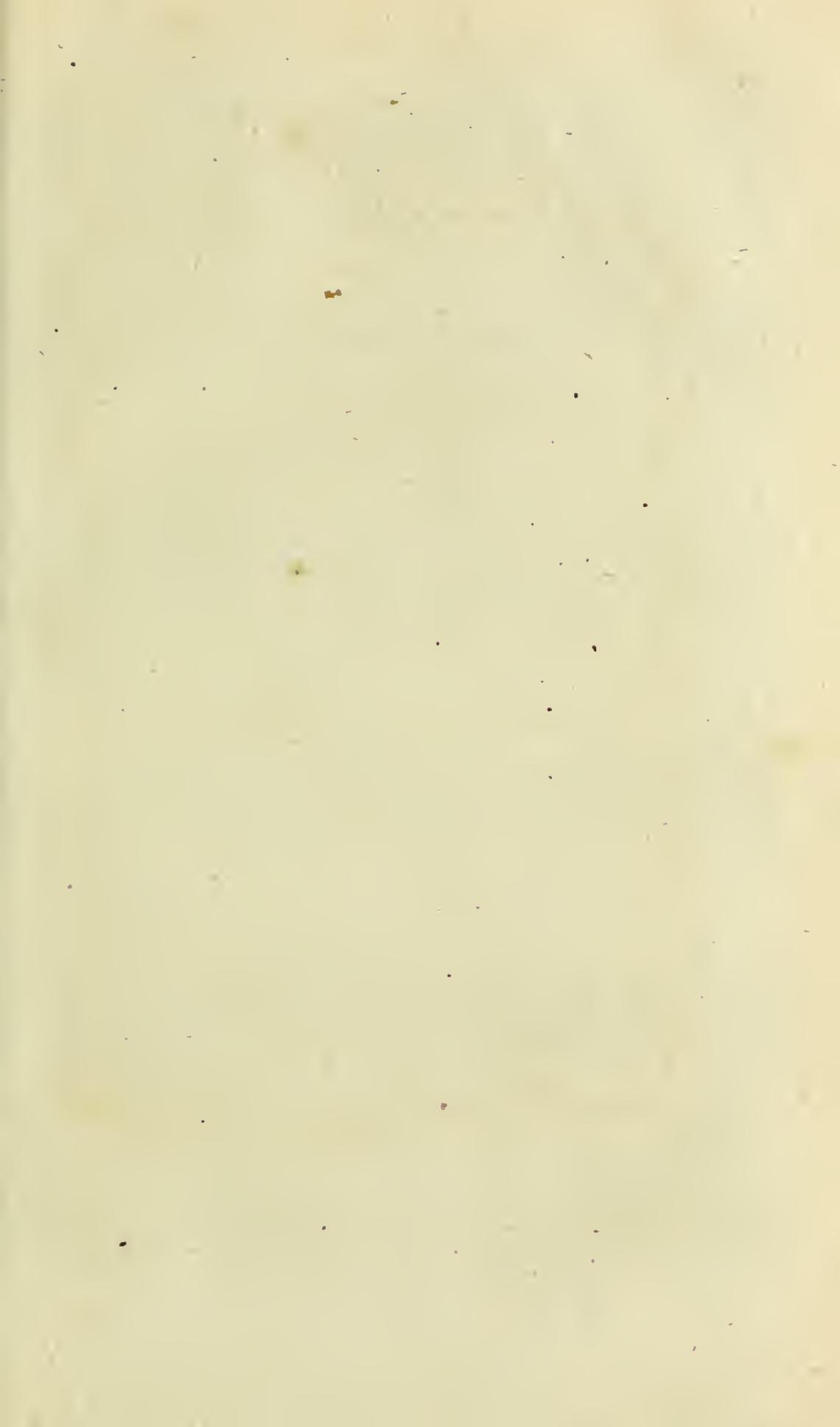
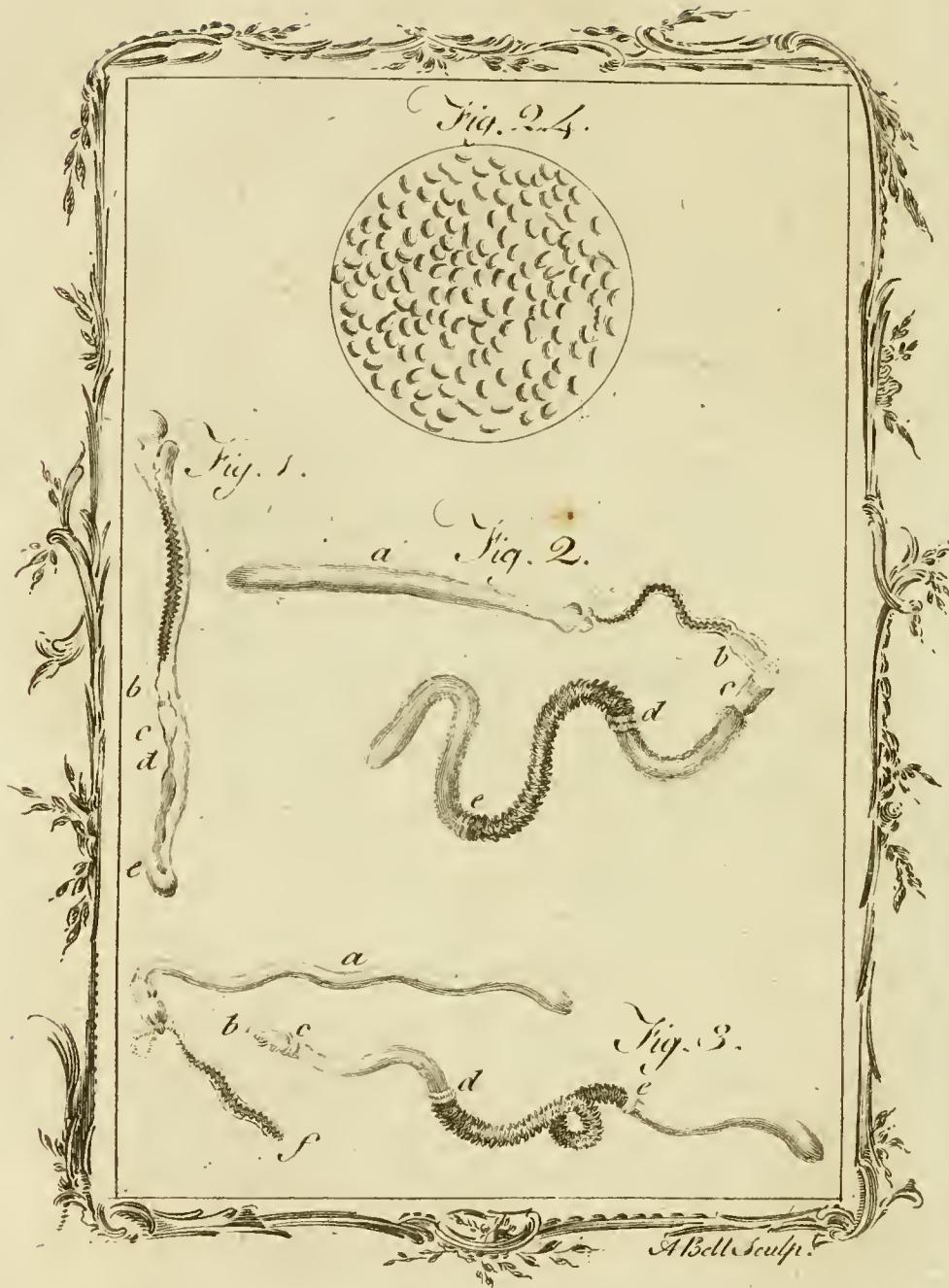


Plate VII.



Abell Sculp.

From this and other analogies, Mr Needham concludes, that the spermatic worms of other animals, it is reasonable to think, are only organic bodies; a species of machines similar to those of the calmar, which act at different times; for, says he, if we suppose that, of the prodigious number of spermatic animalcules which appear in the field of the microscope, only a few thousands act at a time, this will be sufficient to make us believe the whole to be alive. If it be farther supposed, he adds, that the motion of each animalcule lasts, like that of the calmar machines, about half a minute; in this case, the successive action of the small machines would continue for a considerable time, and the animalcules would die one after another. Besides, why should the semen of the calmar alone contain machines, while that of all other animals contain real living animalcules? Here the analogy is so strong as to be almost irresistible. Mr Needham farther remarks, that even Leeuwenhoek's experiments seem to indicate that the spermatic animals have a great resemblance to the organic bodies in the semen of the calmar. Speaking of the semen of the cod, Leeuwenhoek remarks, that he imagined the oval bodies to be animalcules burst and distended, because they were four times larger than when alive. And, in another place, he observes of the semen of a dog, that the animalcules often changed their

their figure, especially when the liquor began to evaporate *.

On all these accounts, Mr Needham conjectured, that the pretended spermatic animals were only a kind of natural machines, bodies much more simply organized than those of real animals. I examined the machines of the calmar along with him, and the reader may be assured that his description of them is both exact and faithful. His experiments, therefore, demonstrate, that the seminal fluid consists of particles in quest of organization ; that, in fact, it produces organized bodies ; but that these bodies are not animals, nor similar to the individual which produces them. It is indeed, probable, that these organized bodies are only a kind of instruments for perfecting the semen, and bestowing on it an active force ; and that it is by their internal action that they intimately penetrate the seminal fluid of the female.

C H A P.

* See Leeuwenh. Arc. nat. p. 306, 309, and 319.

C H A P. VII.

Comparison of my own Experiments with those of Leeuwenhoek.

THOUGH my experiments were made with all the attention of which I was capable, and though I often repeated them, I am satisfied that many things must have escaped me. I have described only what I saw, and what every man may see, at the expence of a little art and patience. To free myself from prejudice, I even attempted to forget what other observers pretended to have seen, endeavouring, by this means, to be certain of seeing nothing but what really appeared; and it was not till I had digested my experiments, that I wished to compare them with those of former writers, and particularly with those of Leeuwenhoek, who had occupied himself more than 60 years in experiments of this kind.

Whatever authority may be due to this acute observer, it is certainly allowable to institute a comparison between a man's own observations, and those of the most respectable writer on the same subject. By an examination of this kind,

truth may be established, and errors may be detected, especially when the only object of inquiry is to ascertain the genuine nature of those moving bodies which appear in the seminal fluids of all animals.

In the month of November 1677, Leeuwenhoek, who had formerly communicated many microscopic observations to the Royal Society of London, concerning the juices of plants, the texture of trees, the optic nerve, rain water, &c. writes to Lord Brouncker, president of the Society, in the following terms: ‘ Postquam * Exc. ‘ Dominus Professor Cranen me visitatione sua ‘ saepius honorarat, litteris rogavis Domino Ham ‘ cognato suo, quasdam observationum mearum ‘ videndas darem. Hic Dominus Ham me se- ‘ cundo invisens, secum in laguncula vitrea semen ‘ viri, gonorrhœa laborantis, sponte destillatum, ‘ attulit, dicens, se post paucissimas temporis mi- ‘ nutas (cum materia illa jam in tantum esset ‘ resoluta ut fistulae vitreæ immitti posset) ani- ‘ malcula viva in eo observasse, quæ caudam et ‘ ultra 24 horas non viventia judicabat: Idem ‘ referebat se animalcula observasse mortua post ‘ sumptam ab aegroto therebintinam. Materi- ‘ am praedicatam fistulae vitreæ immissam, praec- ‘ sente Domino Ham, observavi, quasdamque in ‘ ea creaturas viventes, ac post decursum 2 aut 3 ‘ horarum eamdem solus materiam observans, ‘ mortuas vidi.

‘ Eamdem

* See Phil. Trans. No. 141. p. 1041.

‘ Eamdem materiam (semen virile) non ae-
 ‘ groti alicujus, non diurna conservatione cor-
 ‘ ruptam, vel post aliquot momenta fluidiorem
 ‘ factam, sed sani viri statim post ejectionem, ne
 ‘ interlabentibus quidem sex arteriae pulsibus,
 ‘ saepiuscule observavi, tantamque in ea viven-
 ‘ tium animalculorum multitudinem vidi, ut in-
 ‘ terdum plura quam 1000 in magnitudine a-
 ‘ renae sese moverent; non in toto semine, sed
 ‘ in materia fluida crassiori adhaerente, ingen-
 ‘ tem illam animalculorum multitudinem obser-
 ‘ vavi; in crassiori vero seminis materia quasi
 ‘ sine motu jacebant, quod inde provenire mihi
 ‘ imaginabar, quod materia illa crassa ex tam va-
 ‘ riis cohaereat partibus, ut animalcula in ea se
 ‘ movere nequirent; minora globulis sanguini
 ‘ ruborem adferentibus haec animalcula erant,
 ‘ ut judicem, millena millia arenam grandiorem
 ‘ magnitudine non aequatura. Corpora eorum
 ‘ rotunda, anteriora obtusa, posteriora ferme in
 ‘ aculeum desinentia habebant; cauda tenui lon-
 ‘ gitudine corpus quinque sexiesve excedente,
 ‘ et pellucida, crassitatem vero ad 25 partem cor-
 ‘ poris habente, praedita erant, adeo ut ea quo
 ‘ ad figuram cum cyclaminis minoribus, longam
 ‘ caudam habentibus, optime comparare queam:
 ‘ Motu caudae serpentino, aut ut anguillae in
 ‘ aqua natantis, progrediebantur; in materia vero
 ‘ aliquantulum crassiori caudam oculis deciesve
 ‘ quidem evibrabant antequam latitudinem capilli
 ‘ procedebant. Interdum imaginabar me inter-

‘ noscere posse adhuc varias in corpore horum
 ‘ animalculorum partes, quia vero continuo eas
 ‘ videre nequibam, de iis tacebo. His animal-
 ‘ culis minora adhuc animalcula, quibus non nisi
 ‘ globuli figuram attribuere possum, permista
 ‘ erant.

‘ Memini me, ante tres aut quatuor annos, ro-
 ‘ gatu Domini Oldenburg B. M. semen verile ob-
 ‘ servasse, et praedicta animalia pro globulis ha-
 ‘ buisse; sed quia fastidiebam ab ulteriori inqui-
 ‘ sitione, et magis quidem a descriptione, tunc
 ‘ temporis eam omisi. Jam quoad partes ipsas,
 ‘ ex quibus crassam semenis materiam, quoad
 ‘ majorem sui partem consistere saepius cum ad-
 ‘ miratione observavi, ea sunt tam varia ac multa
 ‘ vasa, imo in tanta multitudine haec vasa vidi,
 ‘ ut credam me in unica semenis gutta plura ob-
 ‘ servasse quam anatomico per integrum diem
 ‘ subiectum aliquod secanti occurrant. Quibus
 ‘ visis, firmiter credebam nulla in corpore hu-
 ‘ mano jam formato esse vasa, quae in semine
 ‘ virili bene constituto non reperiantur. Cum
 ‘ materia haec per momenta quaedam aëri fuisset
 ‘ exposita, praedicta vasorum multitudo in aquo-
 ‘ sam magnis oleaginosis globulis permistam ma-
 ‘ teriam mutabatur, &c.

The secretary of the Royal Society replied to this letter of Leeuwenhoek, that it would be proper to make similar experiments on the seminal fluids of other animals, not only to support the original discovery, but to distinguish whatever differences might appear in the number and figure

figure of the animalcules: And, with regard to the vascular texture of the thick part of the seminal fluid, he suspected that it was only a congeries of filaments, without any regular organization: 'Quae tibi videbatur vasorum congeries, fortassis semenis sunt quaedam filamenta, haud organice constructa, sed dum permearunt vasa generationi inservientia in istiusmodi figuram elongata. Non dissimili modo ac saepius notatus sum salivam crassiorem ex glandularum faucium foraminibus editam, quasi e convolutis fibrillis constantem *.'

Leeuwenhoek replied, 18th March 1678, in the following words: 'Si quando canes coeunt marem a foemina statim seponas, materia quae-
dam tenuis et aquosa (lympha scilicet sperma-
tica) a pene folet paulatim exstillare; hanc
materiam numerosissimis animalculis repletam
aliquoties vidi, eorum magnitudine quae in
semine virili conspicuntur, quibus particulae
globulares aliquot quinquagies maiores per-
miscebantur.

' Quod ad vasorum in crassiori semenis virilis
portione spectabilium observationem attinet,
denuo non semel iterataim, saltem mihi meti pli
comprobasse videor; meque omnino persuasum
habeo, cuniculi, canis, felis, arterias venasve
fuisse a peritissimo anatomico haud unquam
magis perspicue observatas, quam mihi vasa in
semini virili, ope perspicilli, in conspectum
venere.

N 3

Cum

* See Phil. Trans. No. 141. p. 1043.

‘ Cum mihi praedicta vasa primum innotuere,
 ‘ statim etiam pituitam, tum et salivam perspi-
 ‘ cillo applicavi; verum hic minime existentia
 ‘ animalia frustra quaesivi.

‘ A cuniculorum coitu lymphae spermaticaæ
 ‘ guttulam unam et alteram, e femella extillan-
 ‘ tem, examini subjeci, ubi animalia praedicto-
 ‘ rum similia, sed longe pauciora, comparuere.
 ‘ Globuli item quam plurimi, plerique magnitu-
 ‘ dine animalium, iisdem permisti sunt.

‘ Horum animalium aliquot etiam delinea-
 ‘ tiones transmisi; figura, 1. [pl. VI. fig. 1.] ex-
 ‘ primit eorum aliquot vivum (in semine cuni-
 ‘ culi arbitròr) eaque forma quæ videbatur, dum
 ‘ aspiciente me versus tendit. A B C, capitu-
 ‘ lum cum truncō indicant; C D, ejusdem cau-
 ‘ dam, quam pariter ut suam anguilla inter na-
 ‘ tandum vibrat. Horum millena millia, quan-
 ‘ tum conjectare est, arenulae majoris molem vix
 ‘ superant. [Pl. VI. fig. 2. 3. 4.] sunt ejusdem
 ‘ generis animalia, sed jam emortua.

‘ [Pl. VI. fig. 5.] delineatur vivum animalcu-
 ‘ lum quemadmodum in semine canino sese ali-
 ‘ quoties mihi attentius intuenti exhibuit. E F G,
 ‘ caput cum truncō indigitant, G H, ejusdem
 ‘ caudam. [Pl. VI. fig. 6. 7. 8.] Alia sunt in
 ‘ semine canino quae motu et vita privantur,
 ‘ qualium etiam vivorum numerum adeo in-
 ‘ gentem vidi, ut judicarem portionem lymphae
 ‘ spermaticaæ arenulae mediocri respondentem,
 ‘ eorum ut minimum decena millia contineré.’

In another letter to the Royal Society, dated May 31. 1678, Leeuwenhoek adds, ‘ Seminis canini tantillum microscopio applicatum iterum contemplatus sum, in eoque antea descripta animalia numerosissime conspexi. Aqua plurimalis pari quantitate adjecta, iisdem confessim mortem accercit. Ejusdem seminis canini portiuncula in vitro tubulo unciae partem duodecimalem crasso servata, sex et triginta horarum spatio contenta animalia vita destituta pleaque, reliqua moribunda videbantur.

‘ Quo de vasorum in semine genitali existentia magis constaret, delineationem aliqualem mitto, ut in figura A B C D E [pl. VI. fig. 9.] quibus literis circumscripum spatium arenulam mediocrem vix superat.’

I have transcribed these passages from the Philosophical Transactions, because they first appeared in that work, before Leeuwenhoek had formed any theory; and, therefore, they must be more agreeable to truth. After the ingenious author had formed a system of generation, his account of the spermatic animals varies, even in essential articles*.

In the first place, what he says concerning the number of these pretended animalcules is true; but the figure of their bodies corresponds not always to his description. Sometimes the end

next

* Here the author attempts a formal proof that Leeuwenhoek invented the single microscope, and discovered the existence of spermatic animals, before Hartsoeker, which interrupts the argument, is nowise interesting to the reader, and therefore I have here omitted it in the translation.

next the tail is globular, and sometimes cylindrical ; sometimes it is flat, and at other times it is broader than long, &c. With regard to the tail, it is often thicker and shorter than he represents. The vibratory motion he ascribes to the tail, and by which he alleges the animals are enabled to proceed forward, I never could distinguish in the manner he describes. I have seen these moving bodies vibrate eight or ten times, from right to left, or from left to right, without advancing the breadth of a single hair ; and I have observed many of them which never could proceed forward, because this tail, in place of assisting them to swim, was, on the contrary, a small thread attached to the filaments or mucilaginous part of the liquor, and, of course, totally prevented the progressive motion of the body. Even when the tail appeared to have any motion, it resembled only the small bendings of a thread at the end of a vibration. I have seen these threads or tails fixed to the filaments, which Leeuwenhoek calls vessels : I have seen them separate from the filaments, after repeated efforts made by the moving bodies : I have seen them first long, then diminish, and at last disappear. Thus these tails ought to be regarded as accidental appendages, and not as real members of the moving bodies. But, what is more remarkable, Leeuwenhoek expressly affirms, in his letter to Lord Brouncker, that, besides the tailed animals, he observed in this liquor animalcules still more minute that had no tails, and were perfectly

Plate VIII.

*Spermatic Animacules
of the Rabbit. of the Dog.
accordint to the first edition of *Scenewhoek.**

Fig. 2. 3. 4. Fig. 5. 6. 7. 8.

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C.

D.

E. F.

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I. J.

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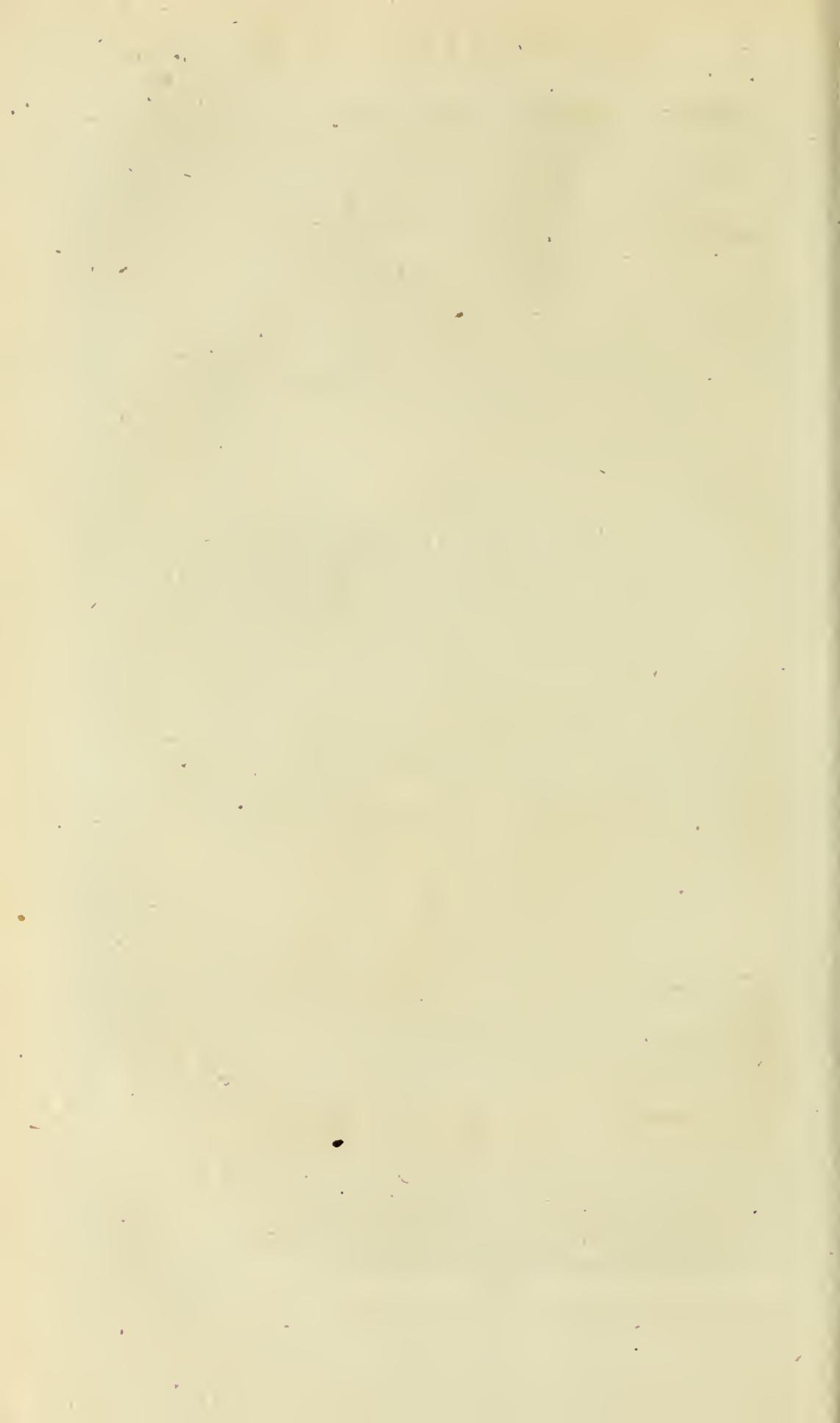
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perfectly globular: 'His animalculis (caudatis
' scilicet) minora adhuc animalcula, quibus non
' nisi globuli figuram attribuere possum, per-
' mista erant.' This is the truth. After Leeu-
wenhoek, however, had maintained that these
animalcules were the only efficient principle of
generation, and that they were transformed in-
to men, he regards as real animals those only
which had tails; and, accordingly, as it was
necessary that animalcules, to be transformed
into men, should have a constant and invariable
figure, he never afterwards mentions the round
animals without tails. I was struck with the
difference between the original composition of
this letter, and the form in which it appeared
twenty years afterwards in his third volume:
For, instead of the words which we have just
now quoted, we meet with the following in
pag. 63. 'Animalculis hisce permistae jacebant
' aliae minutiores particulae, quibus non aliam
' quam globulorum seu sphaericam figuram af-
' signare quo. This is a very different account
of the matter. A particle of matter, to which he
ascribes no motion, is extremely different from
an animalcule. It is astonishing that Leeuwen-
hoek, in copying his own letter, should have
changed an article of so much consequence.
What he immediately subjoins likewise merits
attention. He says, that, at the intreaty of Mr
Oldenburg, he had examined this liquor three
or four years ago; and that he then imagined
these animalcules to be globules. Thus, these
pretended

pretended animalcules are sometimes globules without any sensible motion; sometimes they are globules which move with great activity; sometimes they have tails, and sometimes no tails. Speaking of spermatic animals in general, he remarks *, 'Ex hisce meis observationibus cogitare coepi, quamvis antehac de animalculis in seminibus masculinis agens, scripserim me in illis caudas non detexisse, fieri tamen posse ut illa animalcula aequa caudis fuerint instructa, ac nunc comperi de animalculis in gallorum galinaceorum semine masculino:' Another proof that he has often seen spermatic animals of all kinds, without tails.

Secondly, It is worthy of remark, that Leeuwenhock had very early discovered the filaments which appear in the semen before it be liquified; and that, at that time, when he had not conceived his hypothesis concerning the spermatic animals, he imagined the filaments to be veins, nerves, and arteries. He firmly believed, that all the parts and vessels of the human body might be clearly distinguished in the seminal fluid. He even persisted in this opinion, notwithstanding the representations made to him by Mr Oldenburg, in name of the Royal Society. But, after he conceived the notion of transforming his spermatic animals into men, he never again takes any notice of these vessels. Instead of regarding them as the nerves and blood-vessels

* Tom. 3. p. 371.

sels of the human body already formed in the semen, he does not even ascribe to them their real function, which is the production of the moving bodies. He observes *, 'Quid fiet de ' omnibus illis particulis seu corpusculis praeter ' illa animalcula femini virili hominum inhae- ' rentibus! Olim et priusquam haec scriberem, ' in ea sententia fui praedictas strias vel vasa ex ' testiculis principium secum ducere,' &c. And, in another place, he says, that what he had formerly remarked concerning vessels in the semen deserved no attention.

Thirdly, If we compare the figures 1. 2. 3. and 4. Pl. VIII. IX. which we have represented exactly as they appear in the Philosophical Transactions, with those which Leeuwenhoek caused to be engraved several years after, we shall find very great differences, especially in those of the dead animalcules of the rabbit, 1. 3. and 4. and in those of the dog, which I have also delineated, in order to give a distinct idea of the matter. From all this, it may fairly be concluded, that Leeuwenhoek has not always seen the same phaenomena ; that the moving bodies, which he regards as animals, have appeared to him under different forms ; and that he has contradicted himself with a view to make the species of men and of animals uniform and consistent. He not only varies as to the fundamental part of these experiments, but also as to the manner of making

* Tom. 1. p. 7.

king them ; for he expressly tells us, that he always diluted the semen with water, to separate its parts, and to give more freedom of motion to the animalcules * ; and yet, in his first letter to Lord Brouncker, he says, that, when he mixed the semen of dogs, in which he before had seen innumerable animals, with water, they all instantly died. Thus Leeuwenhoek's first experiments were made, like mine, without any mixture ; and it appears, that he was not in use to mix the liquor with water till long after he began his experiments, and till he conceived the idea that water killed the animalcules ; which, however, is not true : I imagine that the addition of water only dissolves the filaments too suddenly ; for, in all my experiments, I have seen but very few filaments in the liquor, after its being mixed with water.

Leeuwenhoek was no sooner persuaded that the spermatic animalcules were transformed into men and other animals, than he imagined that he saw two distinct kinds in the semen of every animal, the one male, and the other female. Without this difference of sex in the spermatic animalcules, it was difficult, he says, to conceive the possibility of producing males and females by simple transformation. He mentions these male and female animalcules in his letter published in the philosophical Transactions, No. 145. and in several other places †. But he attempts not to describe

* Tom. 3. p. 92. 93.

† See tom. 1. p. 163. and tom. 3. p. 101. of his works,

describe the differences between the male and female animalcules, which never existed but in his own imagination.

The famous Boerhaave having asked Leeuwenhoek, whether he had observed any differences in the growth and size of spermatic animals? Leeuwenhoek replied, that, in the semen of a rabbit which he had opened, he saw an infinite number of animalcules: ‘ Incredibilem,’ says he, ‘ viventium animalculorum numerum ‘ conspexerunt, cum haec animalcula scypho ‘ imposita vitro et illic emortua, in rariores or- ‘ dines disparaſſent, et per continuos aliquot dies ‘ ſaepius viſu examinatam, quaedam ad justam ‘ magnitudinem nondum excreviſſe adverti. Ad ‘ haec quasdam obſervavi particulas perexiles et ‘ oblongas, alias aliis maiores, et, quantum ocu- ‘ lis apparebat, cauda deſtitutas; quas quidem ‘ particulas non niſi animalcula eſſe credidi, quae ‘ ad justam magnitudinem non excreviſſent *.’ Here we have animalcules of different sizes, and some with tails, and others that had no tails, which better correspond with my experiments than with Leeuwenhoek’s ſystem. We only differ in a ſingle article. He conſiders the oblong bodies without tails as young animalcules which have not yet arrived at their full growth: But I, on the contrary, have ſeen theſe pretended animals originally ſpring from the filaments with their tails or threads, which they gradually lost.

In

* See tom. 4. p. 280. 281.

In the same letter to Boerhaave he says *, that, in the semen of a ram he observed the animalcules marching in flocks like sheep: ' *A tribus circiter annis testes arietis, adhuc calentes, ad aedes meas deferri curaveram; cum igitur matrem ex epididymibus eductam, ope microscopii contemplarer, non sine ingente voluptate advertebam animalcula omnia, quotquot innatabant semini masculino, eundem natando cursum tenere, ita nimirum ut quo itinere priora praenatarent, eodem posteriora subsequerenter, adeo ut hisce animalculis quasi sit ingenitum, quod oves factitare videmus, scilicet ut praecedentium vestigiis grex universus incedat.*' This observation, made by Leeuwenhoek in the 1713, and which he regarded as new and singular, is a sufficient proof that he had never so attentively examined the seminal fluids of animals as to enable him to give exact descriptions of them. In the 1713, he was 71 years of age: He had been in the constant practice of making experiments with the microscope for 45 years: He continued to publish his observations during 36 years: And yet, after all this practice, he now, for the first time, observed a phaenomenon which is exhibited in every semen, and which I have described, Exper. IX. in the human semen, Exper. XII. in the semen of a dog, and Exper. XXIX. in the semen of a bitch. To explain the moving of the animalcules of the ram in flocks, therefore,

* Tom. 4. 28.

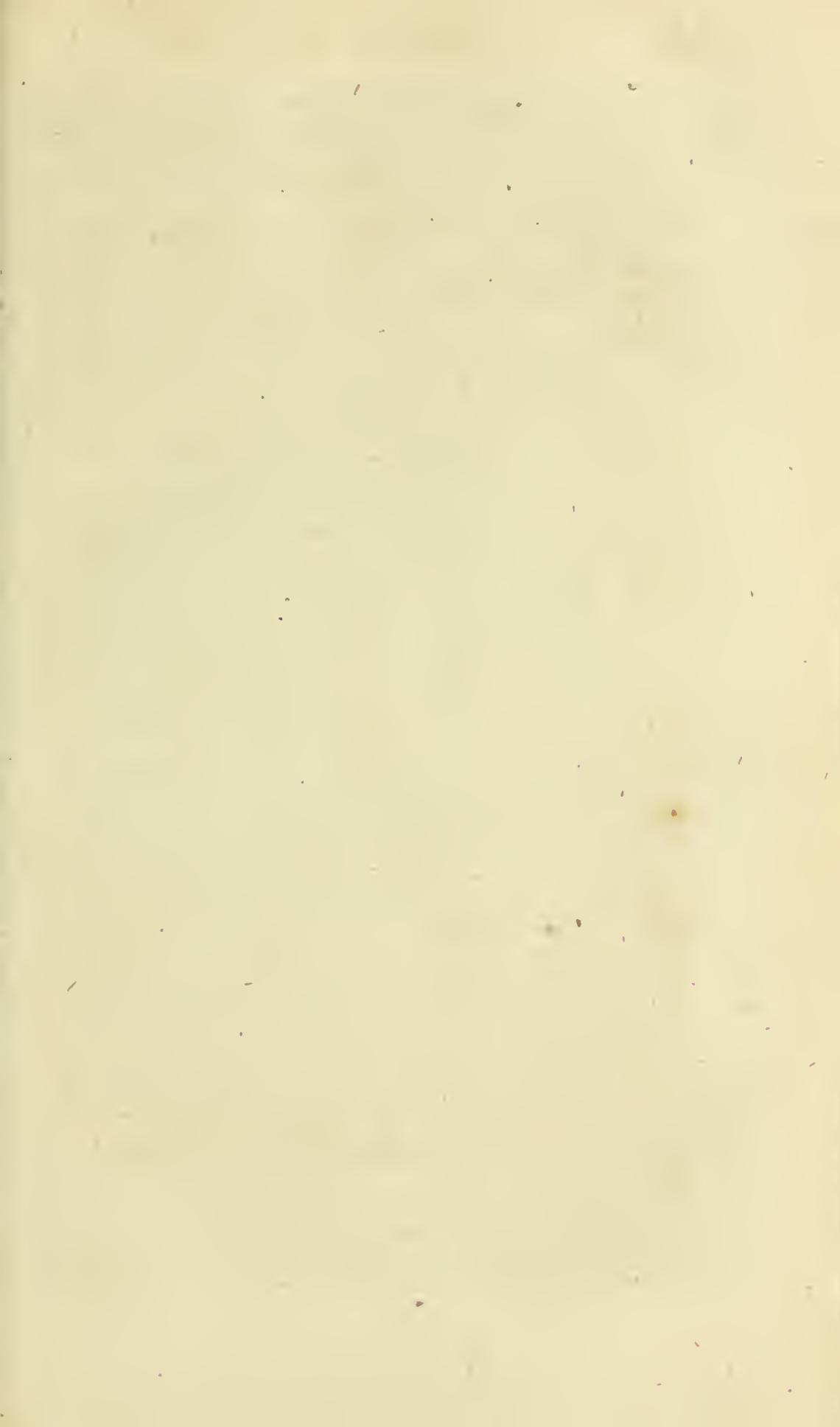
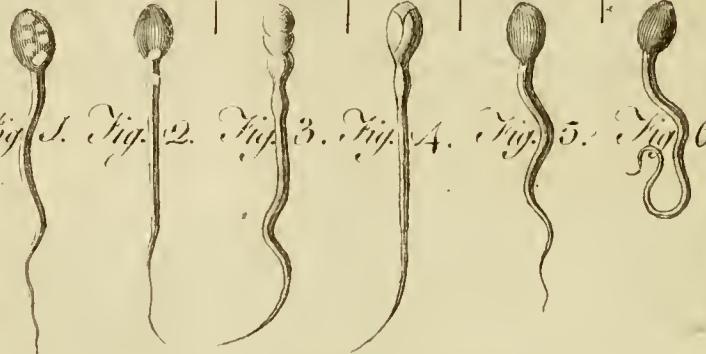


Plate. IX.

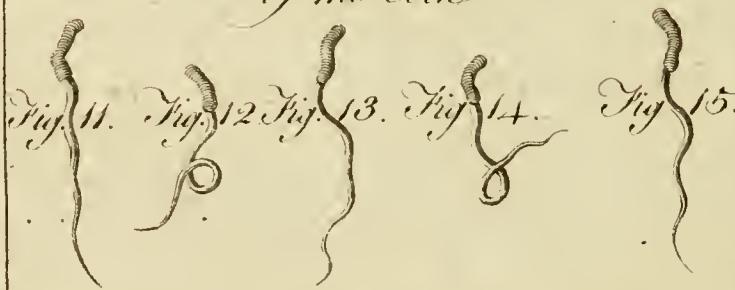
Spermatic Animalcula from last Edition of *Levenhook of the Ram.* [of the Dog.] [of the Rabbit]
 Dated An. L. 1678 Dated An. L. 1678



of the Ram



of the Cock



A Bell Sculp.

therefore, it is unnecessary to suppose them endowed with the natural instinct peculiar to sheep; since those of man, of the dog, and of the bitch, move in the very same manner; and since this motion depends upon particular circumstances, the principal of which is, that the fluid part of the semen should be on one side, and the thick or filamentous part on the other; for then the whole moving bodies disengage themselves from the filaments, and proceed, in the same direction, into the more fluid part of the liquor.

In another letter, written the same year, and addressed to Boerhaave *, he relates some farther observations concerning the semen of the ram: He tells us, that, when the liquor was put into separate glasses and examined, he observed flocks of animalcules moving all in the same direction, and other flocks returning the contrary way. He adds: ‘ Neque illud in unica epididymum parte, sed et in aliis quas precideram partibus, observavi. Ad haec, in quadam parastattarum resecta portione complura vidi animalcula, quae neodium in justam magnitudinem adoleverant; nam et corpuscula illis exiliora et caudae triplo breviores erant quam adultis. Ad haec, caudas non habebant desinentes in mucronem, quales tamen adultis esse passim comperio. Praeterea, in quandam parastattarum portionem incidi, animalculis, quantum discernere potui, destituta, tantum illi quaedam pere exiguae inerant particulae,

* See tom. 4. p. 304.

‘ particulae, partim longiores partim breviores ;
‘ sed altera sui extremitate crassiunculae ; istas
‘ particulas in animalcula transfituras esse non du-
‘ bitabam.’ From this passage, it is apparent that Leeuwenhoek had seen in this seminal liquor, what I have found in the semen of all the animals which I examined, moving bodies that differed in size, figure, and motion ; and these circumstances, it is obvious, correspond better with the notion of organic particles in motion, than with that of real animals.

It appears, therefore, that Leeuwenhoek’s observations, though he draws very different conclusions from them, perfectly correspond with mine : And, though there be some opposition in the facts, I am fully persuaded, that, whoever shall take the trouble of repeating the experiments, will easily discover the source of these differences, and find that I have related nothing but truth. To enable the reader to decide in this matter, I shall add a few remarks.

We do not always see, in the human semen, the filaments I have mentioned : For this purpose, the liquor must be examined the moment it is extracted from the body ; and even then they do not uniformly appear. When the liquor is too thick, it presents nothing but large globules, which may be distinguished with a common lens. When examined with the microscope they have the appearance of small oranges ; they are very opaque, and one of them occupies

cupies the whole field of the microscope. The first time I observed these globules, I imagined them to be foreign bodies which had fallen into the liquor. But, after examining different drops, I found that the whole liquor was composed of these large globules. I observed one of the largest and roundest of them for a long time. At first it was perfectly opaque: A little after, I perceived on its surface, about half way between the centre and circumference, a beautiful coloured luminous ring, which continued more than half an hour, then gradually approached the centre, which became clear and coloured, while the rest of the globule remained opaque. This light, which illuminated the centre, resembled that which appears in large air-bubbles. The globule now began to grow flat, and to have a small degree of transparency: And, after observing it for three hours, I could perceive no other change, no appearance of motion, either internal or external. I imagined that some change might happen by mixing the liquor with water. The globules were indeed changed into a transparent homogeneous fluid, which presented nothing worthy of remark. I left the semen to liquify of its own accord, and examined it at the distance of 6, 12, and 24 hours; but found nothing like life or motion. I relate this experiment to show, that the ordinary phaenomena are not always to be expected in seminal fluids, though they be apparently similar.

Sometimes all the moving bodies have tails, especially in the semen of man, and of the dog; their motion is not then very rapid, and appears to be performed with difficulty. If the liquor be allowed to dry, the tails or threads are first deprived of motion; the anterior extremity continues to vibrate for some time, and then all motion ceases. These bodies may be long preserved in this state; and, if a small drop of water be then poured upon them, their figure changes; they fall down into several minute globules, which appear to have a small degree of motion, sometimes approaching each other, and sometimes trembling, and turning round their centres.

The moving bodies in the human semen, and in those of the dog and bitch, resemble each other so strongly, that it is not easy to distinguish them, especially when examined immediately after they are taken from the body of the animal. Those of the rabbit appear to be smaller and more active. But these differences and resemblances proceed more from the different states of the fluids during the time of examination, than from the nature of the fluids themselves, which ought indeed to be different in different species of animals: For example, in the human fluid, I have remarked large filaments, as represented in pl. III. fig. 3. &c. and I have seen the moving bodies separate from these filaments, from which they appeared to derive their origin. But I could perceive nothing of this kind in the semen

semen of the dog. Instead of distinct filaments, it is generally composed of a compact mucilage, in which we with difficulty perceive some filamentous parts; and yet this mucilage gives birth to moving bodies similar to those in the human semen.

The motion of these bodies continues longer in the fluid of the dog, than in that of man, which enables us more easily to distinguish the change of form above remarked. The moment the fluid issues from the body of the animal, we find most of the animalcules possessed of tails. In 12, 24, or 36 hours afterwards, almost the whole tails disappear; we then perceive only oval bodies moving about, and generally with more rapidity than at first.

The moving bodies are always below the surface of the liquor. Several large transparent air-bubbles commonly appear on the surface: but they have no motion, unless when the liquor is agitated. Below the moving bodies we often perceive others still more minute: These have no tails; but most of them move: And, in general, I have remarked, that, of the numberless globules in all these liquors, the smallest are generally blacker and more obscure than the others; and that those which are extremely minute and transparent have little or no motion. They seem likewise to have more specific gravity; for they are always sunk deepest in the fluid.

C H A P. VIII.

Reflections on the preceding Experiments.

FROM the foregoing experiments, it appears, that females, as well as males, have a seminal fluid containing bodies in motion; that these moving bodies are not real animals, but only organic living particles; and that these particles exist not only in the seminal fluids of both sexes, but in the flesh of animals, and in the seeds of vegetables. To discover whether all the parts of animals and all the seeds of plants contained moving organic particles, I made infusions of the flesh of different animals, and of the seeds of more than twenty different species of vegetables; and, after remaining some days in close glasses, I had the pleasure of seeing organic moving particles in all of them. In some they appeared sooner, in others later. Some preserved their motion for months, and others soon ceased to move. Some, at first, produced large moving globules, resembling animals, which changed their figure, split, and became gradually smaller. Others produced only small globules whose motions were extremely rapid; and others produced

ced filaments, which grew longer, seemed to vegetate, and then swelled, and poured out torrents of moving globules. But it is needless to give a detail of my experiments on the infusions of plants, especially since Mr Needham has published his excellent and numerous observations on this subject. To this able naturalist I have read over the preceding treatise; I have often reasoned with him on the resemblance between the moving bodies in infusions of the seeds of vegetables, and those in the seminal fluids of male and female animals. He thought my views well founded, and of sufficient importance to merit a farther discussion. He, therefore, began to make experiments on the different parts of vegetables; and I acknowledge, that he has brought the ideas I communicated to greater perfection than I could have done. Of this I could give many examples: But I shall confine myself to one, because I formerly pointed out the fact in question, which he describes in the following manner.

To ascertain whether the moving bodies which appear in infusions of flesh were real animals, or only, as I had imagined, organic moving particles, Mr Needham thought that an examination of the jelly of roasted meat would determine the question; because, if they were animals, the fire would destroy them, and, if not, they would still be perceptible, in the same manner as when the flesh was raw. Having, for this purpose, ta-

ken the jellies of veal and of other kinds of roasted meat, he put them in glasses filled with water, and carefully corked the bottles. After some days infusion, he found in the whole of the liquors an immense number of moving bodies. He showed me several of these infusions, and, among others, that of the veal jelly, which contained moving bodies very similar to those in the semen of man, the dog, and the bitch, after they had lost their tails or threads. Though they changed their forms, their motions were so similar to those of animals swimming, that, whoever saw them for the first time, or had been ignorant of what has been formerly remarked concerning them, would certainly have conceived them to be real animals. I shall only add, that Mr Needham has established, by numberless experiments, the existence of moving organic particles in all the parts of vegetables, which confirms what I have alledged, and extends my theory concerning the composition and reproduction of organized beings.

It is apparent, then, that all animals, whether male or female, and every species of vegetable, are composed of living organic particles. These organic particles abound most in the seminal fluids of animals, and in the seeds of vegetables. Reproduction is effected by the union of these organic particles, which are detached from all parts of the animal or vegetable body, and are always similar to the particular species to which they

they belong ; for their union could not be accomplished but by the intervention of an internal mould, which is the efficient cause of the figure of the animal or vegetable, and in which the essence, the unity, and the continuation of the species consists, and will invariably continue till the end of time.

But, before drawing general conclusions from the system I have established, some objections must be removed, which will contribute still farther to illustrate the subject.

It will be demanded of me, why I deny these moving bodies to be animals, after they have uniformly been recognized as such by every man who has examined them ? It may likewise be asked, How is it possible to conceive the nature of living organic particles, unless we allow them to be real animals ? And to suppose an animal to be composed of lesser animals, is nearly the same idea, as when we say that an organized body is composed of organic living particles. To these questions I shall endeavour to give satisfactory answers.

It is true, that almost all observers agree in regarding the moving bodies in the seminal fluid as real animals. But it is equally certain, both from my experiments, and those of Mr Needham upon the semen of the calmar, that these moving bodies are beings more simple, and less organized than animals.

The

The word *animal*, in its common acceptation, represents a general idea, composed of particular ideas which we derive from particular animals. All general ideas include many different ideas, which more or less approach or recede from one another ; and, of course, no general idea can be precise or exact. The general idea we have formed of an animal, may be derived from the particular idea of a dog, of a horse, and of other animals, from the power of volition, which enables them to act according to their inclination, and from the circumstances of their being composed of flesh and blood, from their faculty of choosing and of taking nourishment, from their senses, from the distinction of sexes, and from their power of reproducing. The general idea, therefore, expressed by the word *animal*, includes a number of particular ideas, not one of which constitutes the essence of the general idea : For there are animals which have no intelligence, no will, no progressive motion, no flesh or blood, and appear to be only a mass of congealed mucilage : There are others which cannot seek for their food, and only receive it from the element in which they exist ; others have no senses, not even that of feeling, at least in a perceptible degree. Some have no sexes, or have both in one individual. There remains nothing, therefore, in the properties of an animal, but the power of reproduction, which is common to both the vegetable and animal. It is from the whole

whole taken together that a general idea must be formed ; and, as this whole is composed of different parts, there must of necessity be degrees or intervals between these parts. An insect, in this sense, is less an animal than a dog, an oyster than an insect, and a sea-nettle, or a fresh water polypus, than an oyster : And, as Nature proceeds by insensible degrees, we should find beings partaking of still less animation than a sea-nettle or a polypus. Our general ideas are only artificial methods of collecting a number of objects under one point of view ; and they have, like other artificial methods, the defect of not being able to comprehend the whole. They are indirect opposition to the procedure of Nature, which is uniform, insensible, and always particular. It is to grasp a number of particular ideas under one word, of which we have no clearer notion than that word conveys ; because, when the word is once received, we imagine it to be a line drawn between the different productions of nature ; that every thing above this line is an *animal*, and every thing below it a *vegetable*, which is another word equally general, and employed as a line of separation between organized bodies and brute matter. But, as has already been remarked, these lines of separation have no existence in nature. There are bodies which are neither animals, vegetables, nor minerals ; and every attempt to arrange them under either of these classes must be ineffectual.

For

For example, Mr Trembly, when he first examined the fresh water polypus, spent much time before he could determine whether it was an animal or a vegetable. The reason is plain ; this polypus is perhaps neither the one nor the other ; and all that can be said is, that it has most resemblance to an animal : And, as we are inclined to think, that every organized being is either an animal or a plant, we believe not the existence of any organized body, unless it falls under some of these general denominations, although there must be, and in fact there are, many beings which belong neither to the one nor the other. The moving bodies found in the seminal fluids, and in infusions of the flesh of animals, as well as in those of all parts of vegetables, are of this species : We can neither rank them under animals nor vegetables ; and no man in his senses will ever maintain them to be minerals.

We may, therefore, pronounce, without hesitation, that the great division of natural productions into *animals*, *vegetables*, and *minerals*, comprehends not all material beings ; since beings exist which can be included in none of these classes. Nature passes, by imperceptible steps, from the animal to the vegetable ; but, from the vegetable to the mineral, the passage is sudden, and the interval great. Here the law of imperceptible degrees suffers a violation. This circumstance made me suspect, that, by examining

ning Nature more closely, we should find intermediate organized beings, which, without having the faculty of reproduction, like animals and vegetables, would still enjoy a species of life and motion ; beings which, without having the properties either of animals or vegetables, might enter into the constitution of both ; and, lastly, beings which would consist of the first assemblages of the organic particles mentioned in the preceding chapters.

Eggs constitute the first class of this species of beings. Those of hens and other female birds are attached to a common pedicle, and derive their nourishment and growth from the body of the animal. But, when attached to the ovary, they are not properly eggs ; they are only yellow globes, which separate from the ovary as soon as they acquire a certain magnitude : Such is their internal organization, however, that they absorb nourishment from the lymph contained in the uterus, and convert it into the white, membranes, and shell. Thus the egg possesses a species of life and organization. It grows and assumes a form by its own peculiar powers : It neither lives like an animal, nor vegetates like a plant, nor enjoys the faculty of reproduction. The egg, therefore, is a distinct being, which can neither be ranked with the animal nor mineral kingdoms. If it be alledged that the egg is only an animal production destined for the nourishment of the chick, and ought to be regarded

garded as a part of the hen; I reply, that eggs, whether impregnated or not, are always organized in the same manner; that impregnation changes only a part which is almost invisible; that it grows, and acquires a uniform figure and structure, both externally and internally, independent of impregnation; and, consequently, it ought to be considered as a separate and distinct being.

This will be still more apparent, if we attend to the growth and formation of the eggs of fishes. When the female deposits them in the water, they are properly but the rudiments of eggs, which, being lately separated from the body of the animal, attract and assimilate those particles that are fitted for their nourishment; and thus increase in size by mere absorption. In the same manner as the egg of the hen acquires its white and membranes while floating in the uterus, the eggs of fishes acquire their white and membranes in the water; and, whether they are fecundated by the male's shedding his milt upon them, or they remain unimpregnated, they still arrive at full perfection. It is plain, therefore, that eggs in general ought to be regarded as organized bodies, and as forming a distinct genus from animals and vegetables.

The organized bodies found in the semen of all animals, and which, like those in the milt of the calmar, are natural machines, and not animals, form a second species of the same genus.

They

They are properly the first assemblages of those organic particles so often mentioned ; and, perhaps, they are the constituent particles of all animated bodies. They appear in the semen of every animal, because the semen is only the residue of the organic particles which the animal takes in with its food. The particles, as formerly remarked, assimilated from the food, are those which are most organized, and most analogous to the animal itself : It is of these particles that the semen consists ; and, of course, we ought not to be surprised to find organized bodies in that fluid.

To be satisfied that these organized bodies are not real animals, we have only to reflect upon the preceding experiments. The moving bodies in the semen have been considered as real animals, because they have a progressive motion, and something similar to tails. But, after attending, on the one hand, to the nature of this motion, which is suddenly finished, and never again commences, and, on the other, to the nature of the tails, which are only threads adhering to the moving body, we will begin to hesitate ; for an animal goes sometimes slow, and sometimes fast ; and it sometimes stops, and reposes, without moving at all. These moving bodies, on the contrary, go always in the same direction at the same time ; I never saw them stop and again begin to move ; and, if they once stop, fit is for ever. I demand, if this continued motion, without

out any repose, is common to animals ; and if, from this circumstance, we ought not to doubt concerning the real animation of these moving bodies ? An animal should always have a uniform figure, as well as distinct members : But these moving bodies change their figure every moment ; they have no distinct members ; and there tails are only adventitious matter, and no part of the individual. How, then, can they be esteemed real animals ? In seminal liquors, we see filaments which stretch out, and seem to vegetate ; then they swell and produce moving bodies. These filaments are, perhaps, of a vegetable nature ; but the moving bodies which proceed from them cannot be animals ; for we have no example of vegetables giving birth to animals. Moving bodies are found in all animal and vegetable substances promiscuously. They are not the produce of generation. They have no uniformity of species. They cannot, therefore, be either animals or vegetables. As they are to be met with in every part of animals and of vegetables, but are most abundant in their seeds, is it not natural to regard them as the organic living particles of which animals and vegetables are composed, as particles which, being endowed with motion, and a species of life, ought to produce, by their union, moving and living beings, and, in this manner, form animals and vegetables ?

But,

But, to remove every doubt upon this subject, let us attend to the observations of others. Can the active machines discovered by Mr Needham in the milt of the calmar be regarded as animals? Can we believe that eggs, which are active machines of another species, are also animals? If we examine Leeuwenhoek's representations of the moving bodies found in many different substances, will we not be satisfied, at the first inspection, that they are not animals, since none of them have any members, but are uniformly either round or oval? If we attend to what this famous observer has remarked concerning the motion of these pretended animals, we must be convinced that he was wrong in regarding them as real animals, and we will be more and more confirmed in the opinion, that they are only organic moving particles. We shall give some examples. Leeuwenhoek * gives the figure of the moving bodies in the seminal fluid of a male frog. This figure represents nothing but a thin, long body, pointed at one of the extremities. Let us attend to what he says concerning it: 'Uno tempore caput (that is, the largest extremity of the moving body) crassius mihi apparebat alio; plerumque agnoscebam animalculum haud ulterius quam a capite ad medium corpus, ob caudae tenuitatem, et cum idem animalculum paulo vehementius moveatur (quod tamen tarde fiebat) quasi volumine quodam

* Tom. i. p. 51.

'quodam circa caput ferebatur. Corpus fere
 'carebat motu, cauda tamen in tres quatuorve
 'flexus volvebatur.' Here we have the change
 of figure that I had observed, the mucilage
 from which the moving bodies with difficulty
 disengage themselves, the slowness of their mo-
 tion before they escape from the mucilage, and,
 lastly, a part of the pretended animal in mo-
 tion while the other is dead ; for, a little after-
 wards, he observes, 'movebant posteriorem fo-
 'lum partem, quae ultima morti vicinia esse
 'judicabam.' All this is repugnant to the na-
 ture of an animal, but exactly corresponds with
 my experiments, except that I never saw the
 tail move, but in consequence of an agitation of
 the body. Speaking of the seminal fluid of the
 cod, he says *, 'Non est putandum omnia ani-
 'malcula in semine aselli contenta uno eodem-
 'que tempore vivere, sed illa potius tantum vi-
 'vere quae exitui seu partui viciniora sunt, quae
 'et copiosiori humido innatant prae reliquis vita
 'carentibus, adhuc in crassa materia, quam hu-
 'mor eorum efficit, jacentibus.' If these are
 animals, why were they not all alive ? Why
 did those only live which were in the most fluid
 part of the liquor ? Leeuwenhoek did not observe,
 that the thick part, instead of being a humour
 produced by the animalcules, is a mucilage,
 which gives birth to them. If he had diluted
 the mucilage with water, he would at once have

given

* P. 52.

given life and motion to the whole. The mucilage itself is often nothing else than a mass of those bodies, which begin to move as soon as they can disengage themselves ; and, of course, this thick matter or mucilage, instead of being a humour produced by the animalcules, is only a congeries of the animals themselves, or rather, as formerly remarked, the matter of which they are formed. Speaking of the semen of the cock, Leeuwenhoek, in his letter to Grew, says *,

' Contemplando materiam (seminalem) animad-
 ' verti ibidem tantam abundantiam viventium
 ' animalium, ut ea stupereim ; forma seu externa
 ' figura sua nostrates anguillas fluviatiles refere-
 ' bant, vehementissima agitatione movebantur ;
 ' quibus tamen substrati videbantur multi et ad-
 ' modum exiles globuli, item multae plan-ova-
 ' les figurae, quibus etiam vita posset attribui,
 ' et quidem propter earumdem commotiones ;
 ' sed existimabam omnes hasce commotiones et
 ' agitationes provenire ab animalculis, sicque
 ' etiam res se habebat ; attamen ego non op-
 ' nione solum, sed etiam ad veritatem mihi per-
 ' suadeo has particulæ, planam et ovalem figu-
 ' ram habentes, esse quaedam animalcula inter
 ' se ordine suo disposita et mixta, vitaque adhuc
 ' carentia.' Here we have animalcules, in the
 same seminal fluid, of different forms ; and I am
 convinced, from my own experiments, that, if
 Leeuwenhoek had observed those oval bodies

with attention, he would have perceived that they moved with their own proper force, and, consequently, that they were as much alive as the others. This change of figure, it is true, exactly corresponds with what I had observed: But it does not indicate a uniform species of animals; for, in the present example, if the bodies having the figure of a serpent were genuine spermatic animalcules, each of which was destined to become a cock, and therefore implies a uniform and invariable organization, what was the end and destination of those of an oval figure? He, indeed, afterwards remarks, that these oval bodies might be the same with the serpentine, if we suppose them rolled up in a spiral manner. But still, how is it possible to conceive that an animal, with its body in this restrained posture, should be able to move without extending itself? I, therefore, maintain, that these oval bodies were only the organic particles separated from their threads or tails, and that the serpentine bodies were the same particles, which had not yet been deprived of these appendages, as I have often remarked in other seminal fluids.

Besides, Leeuwenhoek, who believed all these moving bodies to be real animals, who established a system upon that foundation, and who affirmed that spermatic animalcules were transformed into men and other animals, now suspected them to be only natural machines, or moving organic particles. He never entertained a doubt,

but

but that these animalcules contained the large animal in miniature. He remarks *, ' Progenetica ratio animalis ex animalculo in seminibus masculinis omni exceptione major est ; nam, etiam si in animalculo ex semine masculo, unde ortum est, figuram animalis conspicere nequeamus, attamen satis superque certi esse possumus figuram animalis ex qua animal ortum est, in animalculo, quod in semine masculo reperitur, conclusam jacere sive esse : Et quamquam mihi saepius, conspectis animalculis in semine masculo animalis, imaginatus fuerim me posse dicere, en ibi caput, en ibi humeros, en ibi femora ; attamen cum ne minima quidem certitudine de iis judicium ferre potuerim, hucusque certi quid statuere supersedeo, donec tale animal, cuius semina mascula tam magna erunt, ut in iis figuram creaturae ex qua provenit agnoscere queam, invenire secunda nobis concedat fortuna.' This opportunity, so much desired by Leeuwenhoek, happily occurred to Mr Needham. The spermatic animals of the calmar are three or four lines in length, and are visible without the assistance of the microscope. Their whole parts and organization are easily perceived. But they are by no means small calmars, as Leeuwenhoek imagined. They are not even animated, though they have motion, but are only machines, which

* Pag. 67.

ought to be regarded as the first union of the organic particles.

Though Leeuwenhoek had not this opportunity of undeceiving himself, he had, however, observed other appearances which ought to have produced this effect. He had remarked, for example, that the spermatic animals of the dog * often changed their figure, especially when the fluid was nearly evaporated ; that, when dead, they had an opening in the head, which did not appear when they were alive ; and that the head was full and round, during the life of the pretended animal, and flat and sunk after its death : These circumstances should have led him to hesitate concerning the real animation of these bodies, and to think that the phaenomena corresponded more with a machine which emptied itself, like that of the calmar, than with the properties of an animal.

I have said that the motion of these moving bodies, these organic particles, is not similar to the motion of animals, and that there is no intervals in their movements. Leeuwenhoek, in tom. I. p. 168. makes precisely the same remark : ‘ Quotiescunque,’ says he, ‘ animalcula in se- ‘ mine masculo animalium fuerim contemplatus, ‘ attamen illa se unquam ad quietem contulisse, ‘ me nunquam vidisse, mihi dicendum est, si ‘ modo sat fluidae superesset materiae in qua se ‘ commode movere poterant ; at eadem in con- ‘ tinuo

* See tom. I. p. 160.

‘tinuo manent motu, et, tempore quo ipsis mori-
 ‘endum appropinquante, motus magis magisque
 ‘deficit, usquedum nullus prorsus motus in illis
 ‘agnoscendus sit.’ It is difficult to conceive,
 that animals should exist, which, from the mo-
 ment of their birth to their dissolution, should
 continue to move rapidly, without the smallest
 interval of repose; or to imagine that the sper-
 matic animals of the dog, which Leeuwenhoek
 perceived to be as active on the seventh day as
 the moment they proceeded from the body of
 the dog, should be able, during all this time, to
 move with a celerity which no animal on earth
 could persist in for a single hour, especially when
 the resistance arising from the density and tena-
 cility of the fluid is taken into consideration. This
 species of continued motion, on the contrary,
 has an exact correspondence to the nature of the
 organic particles, which, like artificial machines,
 produce their effects by a continued operation,
 and stop immediately afterwards.

In the numerous experiments made by Leeu-
 wenhoek, he doubtless observed spermatic animals
 without tails. He even mentions them in some
 places, and endeavours to explain the phaeno-
 menon. For example, speaking of the semen
 of the cod, he says *, ‘Ubi vero ad lactium ac-
 cederem observationem, in iis partibus quas a-
 nimacula esse censebam, neque vitam neque

P 3

‘caudam

* Tom 2. p. 150.

‘ caudam dignoscere potui ; cujus rei rationem
‘ esse existimabam, quod quamdiu animalcula
‘ natando loca sua perfecte mutare non possunt,
‘ tamdiu etiam cauda concinne circa corpus ma-
‘ neat ordinata, quodque ideo singula animalcula
‘ rotundum repraesentent corpusculum.’ It would
have been more simple, and more agreeable to
truth, to have said, that the spermatic animals of
this fish sometimes have tails, and sometimes
have none, than to suppose that the tails were
so exactly wound round their bodies as to give
them a spherical figure. One would be apt to
think, that Leeuwenhoek had never fixed his
eyes upon, or described any moving particles but
those which had tails ; he has given figures of
none that wanted tails, because, though they mo-
ved, he did not regard them as animals. This is
the reason why all Leeuwenhoek’s figures of
spermatic animals are very similar, and all drawn
with tails. When they appeared in any other
form, he thought they were imperfect, or rather
that they were dead. Besides, it is apparent from
my experiments, that, instead of unfolding their
tails, wherever they are placed in circumstances
proper for swimming, as Leeuwenhoek insists,
these pretended animals gradually lose their tails,
in proportion to the rapidity of their motions,
till, at last, these tails, which are bodies foreign
to the animalcules, or threads which they drag
after them, totally disappear.

Leenwenhoek,

Leeuwenhoek, speaking of the spermatic animals of man *, says: ‘ Aliquando etiam animalcula inter particulas quasdam minores et subrotundas ; cum vero se ea aliquoties eo modo oculis meis exhibuerint, ut mihi imaginarer eas exiguis instructas esse caudis, cogitare coepi annon hae forte particulae forrent animalcula recens nata ; certum enim mihi est ea etiam animalcula per generationem proximare, vel ex mole minuscula ad adultam procedere quantitatem : Et quis scit annon ea animalcula, ubi moriuntur, aliorum animalculorum nutritioni atque augmini inserviant ! ’ It appears from this passage, that Leeuwenhoek had seen, in the human semen, animalcules without tails ; and that he is obliged to suppose them to be recently produced, which is directly the reverse of what I have observed ; for the moving bodies are never larger than when they separate from the filaments, which is the period when their motion begins : But, as soon as they are fully disengaged from the mucilage, they become smaller, and continue to diminish till their motion entirely ceases. With regard to the generation of these animals, which Leeuwenhoek imagines to be certain, no vestige of copulation has been discerned by the most acute observers. It is purely a random assertion, as may be easily proved from his own experiments. He remarks, for example,

with

* Tom. 3. p. 93.

with great propriety, that the milt of the cod * is gradually filled with seminal liquor ; and that, after the fish has spent this liquor, the milt dries, and leaves only a flaccid membrane, entirely destitute of every kind of fluid. ‘ *Eo tempore*,’ says he, ‘ *quo asellus major lactes suo emisit, rugae illae, seu tortiles lactium partes, usque adeo contrahuntur, ut nihil praeter pelliculas seu membranas esse videantur.*’ How should this dry membrane, which contains neither seminal liquor nor animalcules, produce animalcules of the same species next season ? If they were produced by a regular generation, such a long interruption could not take place, which, in most fishes, continues a whole year. To remove this difficulty, he afterwards remarks : ‘ *Necessario statuendum erit, ut asellus major semen suum emiserit, in lactibus etiamnum multum materiae seminalis gig- nendis animalculis aptae remansisse, ex qua materia plura oportet provenire animalcula seminalia quam anno proxime elapsa emissa fuerant.*’ This supposition, that part of the seminal liquor remains in the milt for the production of spermatitic animals the following year, is perfectly gratuitous, and contrary to observation ; for the milt, during this interval, is nothing but a thin dry membrane. But how will he explain a phaenomenon that takes place in some fishes, and particularly in the calmar, whose seminal liquors are not only renewed every year, but even the membranes

* Tom. 3. p. 98.

membranes which contain them? Here neither the milt nor the seminal liquor are preserved till the succeeding year; and, of course, their regular reproduction cannot be ascribed to generation. It is, therefore, apparent, that these pretended spermatic animals are not multiplied, like other animals, by generation; and this circumstance alone would entitle us to conclude, that the moving particles in the seminal fluid are not real animals. Leeuwenhoek, though he tells us, in the passage above quoted, that the spermatic animals are certainly propagated by generation, acknowledges, however, in another place *, that the manner in which these spermatic animals are produced, is exceedingly obscure, and that he leaves to others the farther elucidation of this subject. ‘Persuadebam mihi,’ says he, speaking of the spermatic animals of the dormouse, ‘haecce animalcula ovibus prognasci, quia diversa in orbem jacentia et in semet convoluta videbam; sed unde, quaeso, primam illorum originem derivabimus! an animo nostro concipiemsu-
 rum animalculorum semen jam procreatuum esse in ipsa generatione, hocque semen tam diu in testiculis hominum haerere, usquedum ad annum aetatis decimum-quartum vel decimum-quintum aut sextum pervenerint, eademque animalcula tum demum vita donari, vel in justam staturam excrevisse, illoque temporis articulo generandi maturitatem adesse! sed haec lampada

* Tom. i. p. 26.

' lampada aliis trado.' It is, perhaps, unnecessary to make many remarks on what Leeuwenhoek has here advanced. He saw, in the semen of the dormouse, spermatic animals which were round and without tails ; *in semet convoluta*, says he, because he always supposes that they ought to have tails. He was formerly certain that these animals were propagated by generation : Here he seems to be convinced of the reverse. But, when he learned, that the vine-fretters (*pucerons*) were propagated without copulation *, he laid hold of this idea, in order to explain the generation of spermatic animals. ' Quemadmodum,' says he, ' animalcula haec ' quae pedicularum antea nomine designavimus ' (the pucerons) dum adhuc in utero materno ' latent, jam praedita sunt materia seminali ex ' qua ejusdem generis proditura sunt animalcula, ' pari ratione cogitare licet animalcula in semi- ' nibus masculinis ex animalium testiculis non ' migrare, seu ejici, quin post se relinquant mi- ' nuta animalcula, aut saltem materiam semina- ' lem ex qua iterum alia ejusdem generis ani- ' malcula proventura sunt, idque absque coitu, ' eadem ratione qua supradicta animalcula ge- ' nerari observavimus.' This supposition is not more satisfactory than the preceding ; for, by thus comparing the generation of spermatic animalcules with that of the vine-fretter, we discover not the reason why they are never seen in

the

* See tom. 2. p. 499. et tom. 3. p. 271.

the human semen till the age of 14 or 15; nor do we learn whence they proceed, or how they are yearly renewed in fishes, &c. Notwithstanding all the efforts of Leeuwenhoek to establish the generation of spermatic animals, he leaves the subject in the greatest obscurity, where it probably would have for ever remained, if we had not discovered, by the preceding experiments, that they are not animals, but organic moving particles, contained originally in the food, and found in vast numbers in the seminal liquors of animals, which are the most pure and most organic extracts derived from the food.

Leeuwenhoek acknowledges, that he did not always find animalcules in the male semen; for example, in that of the cock, which he often examined, he never but once saw the eel-like animalcules: And, some years after, he could not discover these eels *, but found animalcules with a large head and a tail, which his drawer could not perceive. He likewise remarks, that, during one season, he could not discover living animals in the seminal fluid of the cod †. All these disappointments proceeded from this circumstance, that, though he saw moving globules, he was unwilling to acknowledge them to be animals, unless they had tails, though it is in the form of globules that they most generally appear, either in seminal fluids, or in infusions of

* See tom. 3. p. 370.

† Tom. 3. p. 306.

of animal and vegetable substances. In the same place, he remarks, that, though he had often distinctly seen the spermatic animals of the cod, he was never able to make his drawer perceive them: ' Non solum,' says he, ' ob eximi-
' am eorum exilitatem, sed etiam quod eorum
' corpora adeo essent fragilia, ut corpuscula pas-
' sim dirumperenter; unde factum fuit ut non-
' nisi raro, nec sine attentissima observatione, ani-
' madverterem particulas planas atque ovorum
' in morem longas, in quibus ex parte caudas
' dignoscere licebat; particulas has oviformes ex-
' istimavi animalcula esse dirupta, quod particu-
' lae hae diruptae quadruplo fere viderentur
' majores corporibus animalculorum vivorum.'

When an animal, whatever be its species, dies, it does not suddenly change its form; from being long like a thread, it does not become round like a bullet; neither does it become four times as large after as before death. Not a single article of what is advanced by Leeuwenhoek, in this passage, has the smallest correspondence to the nature of an animal; but, on the contrary, the whole agrees with a species of machines which, like those of the calmar, burst and empty themselves, after having performed their functions. To pursue this observation a little further: He tells us, that he has seen the spermatic animals of the cod under different forms, ' Mul-
' ta apparebant animalcula sphaeram pellucidam
' repraesentantia,' and of different sizes, ' Haec
' animalcula

‘animalcula minori videbantur mole, quam ubi
‘eadem antehac in tubo vitro rotundo exami-
‘naveram.’ This is an evident proof, that there
is nothing like a uniform and invariable species
in these animalcules, and consequently, that they
are not animals, but only organic moving par-
ticles, which, by their different combinations,
assume various figures and sizes. Of these or-
ganic particles, vast numbers appear in the ex-
tract and in the residue of our food. The mat-
ter which adheres to the teeth, and which, in
healthy persons, has the same smell with the se-
minal fluid, is only a residue of our food. In it
we accordingly find a great quantity of these
pretended animals, some of which have tails,
and resemble those of the seminal fluid. Mr
Baker has given figures of four species of them,
which are all a kind of cylinders, ovals, or glo-
bules, some of them having tails, and others not.
But, after the strictest examination, I am per-
suaded, that none of them are real animals, and
that they are only, like those in the semen, the
organic living particles of the food appearing
under different forms. Leeuwenhoek, who
knew not how to account for these pretended
animals in the matter adhering to the teeth, sup-
poses them to proceed from certain species of
food, as cheese, in which they previously exist-
ed; but they are found among the teeth of e-
very person, whatever kind of food be eaten;
and, besides, they have no resemblance to mites,

or other animalcules which appear in corrupted cheese. In another place, he tells us that these teeth-animals proceed from the cistern-water which we drink, because he observed similar animals in rain-water, especially when it had stagnated upon leaden roofs. But, when we give the history of microscopic animals, we shall demonstrate, that most of those found in rain-water are only organic moving particles, which divide, unite, change their size and figure, and, in a word, which can be made to move or to rest, to live or die, as often as we please.

Most seminal fluids spontaneously dilute, or become more liquid, when exposed to the air or to a certain degree of cold, than when they issue from the body. But they thicken upon the application of a moderate degree of heat. I exposed some of these fluids to a degree of cold equal to that of water just beginning to freeze; but the pretended animalcules suffered not the least injury from it. They moved with equal activity, and during the same length of time, as those to which no cold had been applied. But those which were exposed to a small degree of heat, soon ceased to move, because the liquor thickened. If these moving bodies were animals, they differed in their nature and constitution from all others, to which a moderate degree of heat communicates force and motion, and upon whose bodies cold has the very opposite effects.

Before

Before leaving this subject, upon which I have, perhaps, dwelt too long, I must still add another remark, which may lead to some useful conclusions. These pretended spermatic animals, which are nothing but the organic living particles of food, exist, not only in the seminal fluids of both sexes, and in the remnants of food that adhere to the teeth, but likewise in the chyle and in the excrements. Leeuwenhoek, having met with them in the excrements of frogs, and of other animals which he dissected, was at first greatly surprised; and, not being able to conjecture from whence animals could proceed so similar to those in the seminal liquor he had just been examining, he accuses his own want of dexterity, and supposes, that, in dissecting the animal, he had inadvertently opened the seminal vessels, and that the semen had in this manner been mixed with the faeces. But, having afterwards observed the same phaenomenon in the faeces of other animals, and even in his own, he was then totally nonplussed. It is worthy of remark, that Leeuwenhoek never found animalcules in his own faeces, but when they were liquid. Whenever his stomach was out of order, and his belly was loose, the animalcules appeared; but, when his food was properly concocted, and his faeces were hard, not a single animalcule was to be found, although he diluted the faeces with water. These facts seem perfectly to coincide with

with what we formerly advanced; for, when the stomach and intestines properly perform their functions, the faeces are only the gross dregs of the aliment, and all the nourishing and organic particles are absorbed by the lacteal vessels: In this case we cannot expect to find organic particles in the faeces, which are solely composed of the useless and inert part of our food. But, when the stomach and intestines, from any indisposition, allow the food to pass without being properly digested, then the organic particles mix with the faeces; and, when examined with the microscope, we discover them in the form of living organic bodies. Hence we may conclude, that people who are troubled with looseness should have less seminal liquor, and be less fitted for the purposes of generation, than those of a contrary habit of body.

I have all along supposed that the female furnishes a fluid equally necessary to generation as that of the male. In the first chapter, I endeavoured to prove, that every organized body contains living organic particles; and, in Chap. II. and III. that nutrition and reproduction are effects of the same cause; that nutrition is performed by absorption, or an intimate penetration of organic particles through all parts of the body; and that reproduction is effected by the superplus of these same organic particles, collected from every part of the body, and deposited in reservoirs destined for that purpose. In

Chap.

Chap. IV. I have shown how this theory applies to the generation of man, and other animals which have different sexes. Females being organized bodies, as well as males, they must also have some reservoirs for the reception of the surplus of organic particles returned from all parts of their bodies. This surplus, as it is extracted from every part of the body, must appear in the form of a fluid; and it is this fluid to which I have given the appellation of the Female semen.

This fluid is not inert, as Aristotle pretends, but prolific, and equally essential to generation as the semen of the male. It contains particles distinctive of the female sex, as that of the other sex contains particles proper for the constitution of male organs; and both of them contain all the other organic particles which may be regarded as common to the two sexes: And hence, from a mixture of the two, the son may resemble his mother, and the daughter her father. Hippocrates maintains, that the semen consists of two fluids, one strong, which produces males, and the other weak, which produces females. But, as the seminal fluid is extracted from every part of the body, it is impossible to conceive how the body of a female should produce particles proper for the formation of male organs.

This liquor must enter, by some way or other, into the uterus of viviparous animals; and, in oviparous animals, it must be absorbed by the

eggs, which may be regarded as portable matrixes. Each of these matrixes, or eggs, contains a small drop of the female fluid, in that part which is called the cicatrice. This prolific drop, when the female has had no communication with the male, assumes, as Malpighius observes, the form of a mole or inorganic mass; but, when it is penetrated by the semen of the male, it produces a foetus, which is nourished and brought to perfection by the juices of the egg.

Eggs, therefore, instead of being common to all females, are only instruments employed by Nature for supplying the place of uteri in those animals which are deprived of this organ. Instead of being active and essential to the first impregnation, eggs are only passive or accidental parts, destined for the nourishment of the foetus already formed in a particular part of this matrix, by the mixture of the male and female semen. Instead of existing from the creation, and each including within itself an infinity of males and females, eggs, on the contrary, are bodies composed of a superfluous part of the food, which is more gross, and less organic, than that of which the seminal fluid consists. The egg, in oviparous females, answers the same purposes as the uterus and menstrual flux in the viviparous.

To evince that eggs are destined by Nature only to supply the place of an uterus in such animals

animals as are deprived of this organ, we must consider, that females produce eggs independent of the male. The uterus, in viviparous animals, is a part peculiar to the female sex; in the same manner, female fowls, that want this organ, have the defect amply supplied by the successive production of eggs, which necessarily exist in these females, independent of all communication with the male. To pretend that the foetus pre-existed in the egg, and that eggs are contained, *ad infinitum*, within each other, is equally ridiculous as to maintain that the foetus pre-existed in the uterus, and that the uterus of the first female contained all the uteri that ever were or will be produced.

Anatomists have applied the term *egg* to things of very opposite natures. Harvey, in his aphorism, *Omnia ex ovo*, by the word *egg*, when applied to oviparous animals, means only the bag which includes the foetus and all its appendages. He imagined that he perceived the formation of this egg or bag immediately after the junction of the male and female. But this egg proceeded not from the ovarium of the female: He even asserts, that he could not distinguish the smallest alteration in the ovarium. It is apparent, that there is not here the most distant analogy to what is commonly understood by the word *egg*, unless, perhaps, the figure of the bag might have some faint resemblance to that of an egg. Harvey, though he dissected

many viviparous females, never could perceive any change in their ovaria: He even regards them as glands totally unconnected with the purposes of generation *, though, as we have seen, they undergo very considerable changes. This able anatomist was deceived by the smallness of the glandulous bodies in animals of the deer kind, to which his researches were principally confined. Conradus Peyerus, who made many observations on the testicles of female deer, remarks, ‘ *Exigui quidem sunt damarum testiculi, sed post coitum foecundum, in alterutro eorum, papilla, sive tuberculum fibrosum, semper succrescit; scrofis autem praegnantiibus tanta accedit testiculorum mutatio, ut mediocrem quoque attentionem fugere nequeant †.*’ This author ascribes, with propriety, the reason why Harvey observed no changes in the testicles of the deer, to their smallness. But he is wrong when he tells us, that the changes he had remarked, and which had escaped Harvey, never happened but after impregnation.

Harvey was deceived in several other essential articles. He insists, that the semen never enters the uterus, and that it is impossible it should find admittance; and yet Verheyen found a great quantity of male semen in the uterus of a cow, which he dissected six hours after copulation ‡. The celebrated Ruyfch informs us, that,

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* See Harvey, Exercit. 64. and 65.

† See Conrad. Peyer. Merycolog.

‡ See Verheyen, sup. anat. tra. 5. cap. 3.

in dissecting a woman who had been killed immediately after the act of adultery, he found a considerable quantity of male semen, not only in the uterus, but in the Fallopian tubes *. Valenieri likewise assures us; that Fallopius, and other anatomists had discovered male semen in the uteri of several women. This point, therefore, though denied by Harvey, is established by the positive testimony of several able anatomists; and particularly by Leeuwenhoek, who found male semen in the uteri of many different species of females.

Harvey mentions an abortion, in the second month, as large as a pigeon's egg, without any appearance of a foetus. In this also he must have been deceived; for Ruysch, and several other anatomists, maintain, that the foetus is distinguishable by the naked eye, even in the first month of pregnancy. In the History of the French Academy, we have an account of a foetus completely formed on the twenty-first day after impregnation. If, to these authorities, we add that of Malpighius, who distinguished the chick in the cicatrice immediately after the egg issued from the body of the hen, we cannot hesitate in pronouncing that the foetus is formed immediately after copulation; and, consequently, no credit is due to what Harvey says concerning the increase of the parts by juxtaposition; since these parts exist from the beginning,

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and

* See Ruysch *Thes. anat.* p. 90. tab. VI. fig. 1.

and gradually expand till the foetus be perfectly mature.

De Graaff differs widely from Harvey in his acceptance of the word *egg*. He maintains, that the female testicles are real ovaria, and contain eggs similar to those of oviparous animals, except that they are much smaller, never fall out of the body, nor detach themselves till after impregnation, when they descend from the ovarium into the uterus. The experiments of De Graaff have contributed more to the belief of the existence of eggs, than those of any other anatomist. They are, notwithstanding, totally void of foundation; for this celebrated author, in the first place, mistakes the vesicles of the ovarium for eggs, though they are inseparable from the ovarium, form a part of its substance, and are filled with a species of lymph. 2. He is still more deceived, when he informs us, that the glandulous bodies are only the coverings of these eggs or vesicles; for it is certain, from the observations of Malpighius and of Valisnieri, and from my own experiments, that the glandulous bodies contain no vesicles. 3. He is wrong in maintaining that the glandulous bodies never appear till after impregnation. On the contrary, these bodies are uniformly found in all females, after the age of puberty. 4. He errs in supposing that the globules which he saw in the uterus, and which contained the foetuses, were the very vesicles that had descended from the ovarium into the uterus,

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and that, he remarks, had become ten times smaller than when they were in the ovary. This circumstance alone of their diminished size should have convinced him of his mistake. 5. He is equally unfortunate in maintaining that the glandulous bodies are only the coverings of the fecundated eggs, and that the number of coverings or empty follicles always correspond to the number of foetuses. This assertion is the reverse of truth; for, on the testicles of all females, we uniformly find a greater number of glandulous bodies, or cicatrices, than of foetuses actually produced; and they even appear in those which never brought forth. To this we may add, that neither he, Verheyen, nor any other person, ever saw the egg in this pretended covering, or in its follicle, though they have thought proper to rest their system upon that supposition.

Malpighius, who distinguished the growth of the glandulous bodies in the female testicle, was deceived when he imagined that he once or twice discovered the egg in their cavities; for this cavity contains only a fluid; besides, after numberless experiments, no man has ever been able to discover any thing that had the most distant resemblance to an egg.

Valisnieri, who is never deceived with regard to facts, is wrong in maintaining that the egg must exist in the glandulous body, though neither

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he, nor any man else, was ever able to discover it.

Let us now attend to what may be esteemed the real discoveries of these anatomists. De Graaff was the first who discovered that the testicles of females suffered any change; and he was right in maintaining that they were parts essentially necessary to generation. Malpighius demonstrated, that the glandulous bodies gradually grew to maturity, and that, immediately after, they were obliterated, and left behind them a slight cicatrice only. Valisnieri illustrated this subject still farther. He discovered that these glandulous bodies were found in the testicles of all females; that they were considerably augmented in the season of love; that they increased at the expence of the lymphatic vesicles of the testicle; and that, during the time of their maturity, they were hollow and full of liquor. These are all the truths we have learned concerning the pretended ovaria and eggs of viviparous animals: What conclusions are we to draw from them? Two things appear to be evident: The one, that no eggs exist in the testicles of females; the other, that there is a fluid both in the vesicles of the testicle, and in the cavity of the glandulous bodies; and we have demonstrated, in the preceding experiments, that this last fluid is the true female semen, because it contains, like that of the male, spermatic animals, or rather organic particles, in motion.

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The seminal fluid of females, therefore, being thus fully ascertained, after what has been said, we must be satisfied that the seminal fluid in general is the superfluous organic part of our food, which is transmitted from all parts of the body to the testicles and seminal vessels of males, and to the testicles and glandulous bodies of females. This liquor, which issues through the nipples of the glandulous bodies, perpetually bedews the Fallopian tubes, and may easily find admission into them, either by absorption, or by the small aperture at their extremity, and in this manner may descend into the uterus. But, on the supposition of the existence of eggs, which are ten or twenty times larger than the aperture of the tubes, it is impossible to conceive the possibility of their being transmitted to the uterus.

The liquor shed by females in the paroxysm of love, which De Graaff supposes to proceed from lacunae about the neck of the uterus and the orifice of the urethra, may be a portion of the superfluous fluid that continually distills from the glandulous bodies upon the Fallopian tubes. But perhaps this liquor may be a secretion of a different kind, and no way connected with generation. To decide this question, microscopic observations would be necessary; but *all* experiments are not permitted even to philosophers. I am inclined to think, that, in this liquor, the same spermatic animals, or moving bodies, would be found as appear in the fluid of the glandulous bodies,

bodies. Upon this subject, I might quote the authority of an Italian physician, who had an opportunity of trying this experiment, which is thus related by Valisnieri * : ‘ Aggiugne il lo-
‘ dato sig. Bono d'avergli anco veduti (animali
‘ spermatici) in questa linfa o siero, diro così
‘ voluttuoso, che nel tempo dell' amorosa zuffa
‘ scappa dalle femine libidinose, senza che si po-
‘ tesse sospettare che fossero di que' del maschio,
&c. If the fact be genuine, as I have no rea-
son to doubt, it is certain that this liquor is the
same with that contained in the glandulous bo-
dies, and, of course, that it is a real seminal
fluid, which escapes through the lacunae of De
Graaff, situated about the neck of the uterus.

Hence we may conclude, that the most libidi-
nous females will be the least fruitful, because
they throw out of the body that fluid which
ought to remain in the uterus for the formation
of the foetus. We likewise learn why common
prostitutes seldom conceive, and why women in
warm climates, who have more ardent desires
than those of colder regions, are less fertile.
But of this we shall afterwards have occasion to
treat.

It is natural to imagine that the seminal fluid
of either sex should not be fertile, unless when it
contains moving bodies. But this point is still
undetermined. The Italian physician, mentioned
above, alledges, that he never found spermatic
animals

* Tom. 2. p. 136.

animals in his semen till he arrived at 40 years, although he was the father of many children, and continued, after the animalcules appeared, to beget more.

The spermatic moving bodies may be regarded as the first assemblages of the organic particles which proceed from all parts of the body; and, when a great number of them unite, they become perceptible by means of the microscope. But, when the number united is small, the body they form is too minute to be visible, and no motion will appear in the seminal fluid, a case which not unfrequently happens. But a long train of successive experiments would be necessary to ascertain the causes of the different states in which this fluid appears.

Of one thing I am certain, from repeated trials, that a seminal liquor, though no motion can be perceived when it is first taken from the body, after being three or four days infused in water, produces as great a number of organic moving particles, as another semen, treated in the same manner, which at first contained vast multitudes. These moving bodies appear likewise in infusions of the blood, of the chyle, of the flesh, and even of the urine, as well as in infusions of all parts of vegetables; and those which appear in all these different substances seem to have nothing peculiar to them. They all move and act nearly in the same manner. If we will have these bodies to be animated, it must be allowed,

lowed, that they are very imperfect, and ought to be regarded only as the rudiments of animals, or rather as bodies composed of particles essential to the existence of animals. As Nature's productions are uniform, and advance by imperceptible degrees, there is no improbability in supposing the existence of organized bodies which properly belong not either to the animal or vegetable kingdoms.

However this matter may stand, it is fully ascertained, that all animal and vegetable substances contain an infinite number of living organic particles. These particles successively assume different forms, and different degrees of activity, according to different circumstances. They are more abundant in the seminal fluids of both sexes, and in the seeds of plants, than in any other part of the animal or vegetable. There exists, therefore, in vegetables and animals, a living substance which is common to them both; and this substance is the matter necessary to their nutrition. The animal is nourished by vegetable or animal substances; and the vegetable is nourished by the same substances in a decomposed state. This common nutritive substance is always alive and active. It produces an animal or vegetable, whenever it finds an internal mould or matrix accommodated to the one or the other, as has already been explained. But, when this active substance is collected too abundantly in a place where it has an opportunity of uniting,

uniting, it forms, in the animal body, other living creatures, as the tape-worm, the ascarides, the worms sometimes found in the veins, in the sinuses of the brain, in the liver, &c. Animals of this kind owe not their existence to the generation of individuals of the same species. It is, therefore, natural to think, that they are produced by an extravasation of the organic matter, or by an inability in the lacteal vessels to absorb the quantity of it presented to them. But we shall afterwards have occasion to examine more in detail the nature of these worms, and of other animals which are produced in a similar manner.

When this organic matter, which may be considered as an universal semen, is assembled in great quantities, as in the seminal fluids, and in the mucilaginous part of the infusions of plants, its first effect is to vegetate, or rather to produce vegetating beings. These zoophytes swell, extend, ramify, and then produce globular, oval, and other small bodies of different figures, all of which enjoy a species of animal life ; they have a progressive motion, which is sometimes very rapid, and sometimes more slow. The globules themselves decompose, change their figure, and become smaller ; and, in proportion as they diminish in size, the rapidity of their motion increases.

I have sometimes imagined, that the venom of the viper, and even the poison of enraged animals,

mals, might proceed from this active matter being too much exalted. But I have not yet had leisure for experiments of this kind, nor for ascertaining the nature of different drugs. All I can say at present is, that infusions of the most active drugs abound with moving bodies, and that they appear sooner in them than in other substances.

Almost all microscopic animals are of the same nature with the moving bodies in the seminal fluids, and in infusions of animal and vegetable substances. The eels in paste, in vinegar, &c. are all of the same nature, and derived from the same origin. But the proofs and illustrations relative to this subject, we shall reserve till we give the particular history of microscopic animals.

C H A P.

C H A P. IX.

Varieties in the Generation of Animals.

THE nutrition and the reproduction of animals and of vegetables, are thus effected by the same matter. It is a substance universally prolific, and composed of organic particles, the union of which gives rise to all organized bodies. Nature always works on the same stock, and this stock is inexhaustible. But the means she employs to give it value are various; and these general varieties and affinities merit the attention of philosophers, because from them we are enabled to account for particular exceptions to the common plan of her operations.

In general, large animals are less prolific than small ones. The whale, the elephant, the rhinoceros, the horse, man, &c. produce but one, and very rarely two, at a birth. But small animals, as rats, herrings, and insects, produce a great number. Does this difference proceed from the greater quantity of nourishment necessary to support the large animals than the small, and from the former having a less proportional quantity of superfluous nutritive particles,

ticles, capable of being converted into semen, than the former? It is certain, that the small animals eat more, in proportion to their bulk, than the large. But it is likewise probable, that the prodigious increase of the smaller animals, as bees, flies, and other insects, may be owing to the extreme fineness and delicacy of their organs and members, by which they are enabled to select the most substantial and most organic parts of the animals and vegetables, from which they extract their nourishment. A bee, which lives upon the purest and most refined parts of flowers, receives from its food a greater proportional quantity of organic particles than a horse, who feeds upon hay, straw, and the grosser parts of vegetables. The horse, accordingly, produces but one at a time, while the bee produces many thousands. The oviparous animals are, in general, smaller than the viviparous, and they are likewise much more prolific. The long time that the foetus remains in the uterus of viviparous animals, is another obstacle to multiplication: During gestation, and the suckling of the young, no new generation can take place. But the oviparous animals, which produce, at the same time, both uterus and foetus, and throw them out of the body, are almost perpetually in a condition to reproduce; and it is well known, that, if a hen be prevented from sitting, and be fully fed, the number of her eggs may be greatly increased. If hens lay not while they brood,

it is because they cease to eat; and for this purpose they leave not their nests but once a day, and even then for a very short time, lest their eggs should be injured by the cold. During this operation, they take not above one tenth part of their ordinary nourishment.

Animals which produce but one at a birth, acquire nearly their full growth before they are fit for generating. But those which produce many, generate before they are half grown. Man, the horse, the ass, the sheep, are incapable of generation till after they have nearly acquired their full growth. It is the same with pigeons and other birds which lay only a small number of eggs: But those which are more prolific, as cocks and hens, fishes, &c. begin to generate much sooner. A cock is capable of this operation at the age of three months, when he is not above one third of his full size. A fish, which, in 20 years, will weigh 30 pounds, generates the first or second year, when it weighs not, perhaps, more than half a pound. But experiments are still wanting to ascertain the growth and duration of fishes: Their age may be discovered by examining with a microscope the annual rings or strata of which their scales are composed. But we are ignorant how far this may extend. I have seen, in the Count de Maurepas' ponds, carps which were well attested to be at least 150 years old, and they appeared to be equally active and lively as common carps.

I will not say with Leeuwenhoek, that fishes are immortal, or, at least, that they cannot die of old age. Every thing, in time, must perish. Whatever has an origin, a birth, or commencement, must arrive at a termination or death. But fishes, by living in a uniform element, and being sheltered from the injurious vicissitudes of the air, must continue longer in the same state than other animals, especially if these vicissitudes, as Bacon remarks, be the chief causes of the destruction of animated beings. But the principal cause of the longevity of fishes is, that their bones are softer than those of other animals, and do not perceptibly harden with age. The bones of fishes lengthen, and turn thick without acquiring more solidity. But the density of the bones of other animals continually increases; and, when their interstices are completely filled and obstructed, the circulation of their fluids ceases, and death ensues. But, in the bones of fishes, this augmentation of solidity, which is the natural cause of death, proceeds in such an imperceptible manner, that they must live very long before they can feel any of the effects of old age.

All quadrupeds covered with hair are viviparous, and those covered with scales are oviparous. The close texture of the shells or scales of oviparous animals prevents them from losing so much matter by transpiration, as makes its way through the porous skins of the viviparous.

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May not this retention of superfluous nourishment, which cannot escape by transpiration, be one reason of the extraordinary fertility of these animals, and of their being able to subsist a long time without food ? All birds and flying insects are oviparous, except some species of flies which produce their young alive *. These have no wings immediately after their birth ; but they gradually shoot out as the animal advances in growth ; and they are not in a condition to be used till it acquires full maturity. All shell-fishes are oviparous ; and likewise those reptiles that have no feet, as snakes and serpents ; they change their skins, which are composed of small scales. The viper is but a slight objection to this general rule ; for it is not properly viviparous. It first produces eggs, from which the young are hatched : This operation is indeed carried on and completed in the body of the mother ; and, instead of laying the eggs, like other oviparous animals, the viper hatches them within the body. The salamander, in which, as Maupertuis remarks †, both eggs and young are found at the same time, is a similar exception in oviparous quadrupeds.

Most animals are multiplied and perpetuated by copulation. But many animals, as the greatest number of birds, propagate rather by a kind of compression, than a proper copulation. Some

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birds;

* See Leeuwenhoek, tom. 4. p. 91.

† Mem. de l'Acad. année 1727, p. 32.

birds, indeed, as the ostrich, the male-duck, &c. have considerable members, and propagate by a real intromission. Male fishes approach the females in the season of spawning. They seem to rub their bellies against each other; for the male often turns on his back to meet the belly of the female. But no actual copulation takes place. The part necessary for this operation does not exist; and the males only approach the females for the purpose of shedding the liquor of their milts upon the eggs, which at that season drop from the females. The male seems to be more attached to the eggs than to the female; for, when she ceases to throw out the eggs, the male instantly abandons her, and follows, with ardor, the eggs which are carried down by the stream, or dispersed by the wind. He passes and repasses a thousand times over every place where he finds eggs. It is not, surely, for the love of the mother that he makes all these movements: He cannot even be supposed to know her; for he has been often seen shedding his semen promiscuously on all the eggs that came in his way, without having ever met with the female to which they belonged.

Thus some animals are distinguished by sexes, and endowed with members proper for copulation. There are others which likewise have sexes, but want the necessary members. Others, as snails, have both members and both sexes in each individual. Others, as the vine-fretters, have

no sexes, are equally fathers and mothers, and produce of themselves without copulation. Though they seem to copulate at pleasure, we are unable to discover the use of the junction, or whether it be really a sexual embrace; unless we should suppose Nature to have endowed this small insect with generative faculties superior to those of any other species of animals, and to have bestowed on every individual not only the power of reproduction, but likewise the power of multiplying by sexual communications.

But, whatever varieties take place in the generation of different species of animals, Nature prepares the body for it by a new production, which, whether it be external or internal, always precedes generation: Immediately before the season of impregnation, the ovaria of oviparous animals, and the testicles of the females of the viviparous, undergo a considerable change. The oviparous animals produce eggs, which gradually increase in size, till they quit the ovarium and fall into the canal of the uterus, where they receive their white, their membranes, and their shell. This production marks the fecundity of the female, and without which generation could not be effected. In viviparous females, in the same manner, one or more glandulous bodies appear upon the testicles, which gradually grow under the membranes that cover them. These glandulous bodies increase, and pierce, or rather elevate the membrane of the testicle; and, when

they arrive at maturity, a fissure, or several little holes, appear at their extremities, through which the seminal fluid escapes, and falls into the uterus. These glandulous bodies are new productions, which always precede generation, and without which it could not be effected.

Males undergo a similar change before they are fit for the purposes of generating. In the oviparous animals, the seminal reservoirs are filled, and sometimes the reservoirs themselves are annually renewed. The milts of some fishes, and particularly of the calmar, are renewed every year. The testicles of birds, immediately before the season of their amours, swell to an enormous degree. The testicles of the males of viviparous animals, especially of those which have seasons, likewise swell considerably; and, in general, the genitals of every species suffer an erection, which, though it be external and casual, may be regarded as a new production that necessarily precedes the faculty of generating.

Thus in all animals, whether male or female, generation is always preceded by new productions; and, when there is properly no new production, some of the parts swell and extend to a remarkable degree. In some animals, not only a new production appears, but their whole bodies are renewed, before generation can be effected; as happens in the surprising metamorphosis of insects, which seems to be intended for no other purpose than to enable these animals

imals to propagate their species ; for their bodies are full grown before they are transformed. The insect, immediately before its transformation, ceases to take nourishment ; and it has no organs proper for generation, no means of converting the nutritive particles, with which it abounds more than any other species of animals, into eggs, or a seminal fluid. Hence the whole of this great surplus of nutritive particles at first unites and moulds itself into a form nearly resembling that of the original animal. The caterpillar becomes a butterfly, because, having no organs of generation, no reservoirs for containing the superfluous nutritive particles, and, consequently, being incapable of producing minute organic bodies similar to the animal itself, the organic nutritive particles, which are always active, assume, by their union, the form of a butterfly, partly resembling that of a caterpillar, both internally and externally, except that the parts of generation are unfolded, and rendered capable of receiving and transmitting the nutritive organic particles which form the eggs and individuals peculiar to the species. The individuals produced by the butterfly ought not to be butterflies, but caterpillars ; because it was the caterpillar that received the nourishment, and because the organic particles of this nourishment must therefore be assimilated into the form of a caterpillar, and not of a butterfly, which is only an occasional production of the superfluous nourishment

nourishment that precedes the real production of animals of this species, and a method employed by Nature to accomplish the important purposes of generation, similar to the production of glandulous bodies, and of milts, in other animals.

When the superabundant quantity of organic nutritive particles is not great, as in man, and most large animals, generation does not take place till the growth of the body is nearly completed; and even their prolific powers are limited to a small number of young: But, when these particles are more abundant, as in birds, and oviparous fishes, generation is effected before the animal be fully grown, and the production of individuals is very numerous. When the quantity of organic nutritive particles is still greater, as in insects, it first produces a large organized body, retaining the internal and essential constitution of the animal, but differing in several parts as the butterfly differs from the caterpillar; and then it quickly generates an amazing number of young, similar to the animal that first prepared the organic nourishment from which they derived their origin. Lastly, when the quantity of superfluous nourishment is very great, and when the animal, at the same time, possesses the organs necessary to generation, as in the vine frettters, it first confers on each individual the power of generating, and then a transformation like that which other insects undergo: The vine fretter becomes a fly; but

it can produce nothing, because it is only the residue of the organic particles that had not been employed in the production of the young.

Almost all animals, man excepted, have certain annual seasons appropriated to the purposes of generation. To birds, spring is the season of love: Carps, and several other fishes, spawn in June and August. Pikes, and some other fishes, spawn in the spring. Cats have three seasons annually, in the months of January, May, and September. The roe-deer rut in December, wolfs and foxes in January, horses in summer, stags in September and October; and almost all insects generate during the autumn only. Some animals, as the insects, are totally exhausted by generation, and die soon after. Others, though they die not, become feeble, are much emaciated, and require a considerable time to repair the great waste of their organic substance. Others are less affected, and are capable of frequently renewing their amours; lastly, man is very little affected, or, rather, he quickly repairs the loss, and therefore is, at all times, in a condition for propagating. All these varieties depend solely on the particular construction of the animal organs. The limits fixed by Nature upon the modes of existing are equally conspicuous in the manner of taking and digesting the food, in the means employed for retaining or throwing it out of the body, and in the instruments by which the organic particles necessary

to

to reproduction are extracted. And, upon the whole, it is apparent, that every thing exists which can exist.

The times of the gestation of females are equally various: Some, as mares, carry their young from eleven to twelve months; others, as women, cows, and hinds, carry their young nine months; others, as foxes and wolves, carry five months; bitches carry nine weeks, cats six weeks, and rabbits thirty-one days. Most birds are hatched in twenty-one days; though some of them, as the thistle-finches, hatch in thirteen or fourteen days. Here the variety is equally great as in every other part of the oeconomy of animals: The largest animals produce fewer young, and carry them longest, which confirms the doctrine, that the quantity of organic nourishment is proportionally less in large than in small animals; for the foetus derives its growth and the expansion of its parts from the superfluous nourishment of the mother; and, as this growth requires longer time in large than in small animals, it is a proof that the quantity of organic particles is not so great in the former as in the latter.

Animals, therefore, are much diversified as to the time and manner of gestation, of engendering, and of producing; and this variety originates from the very causes of generation. For, though the organic matter, which is common to every thing that lives or vegetates, be the general

ral principle of reproduction, the manner of its union, and the combinations it forms, must be infinitely varied, that the whole may become the sources of new productions. My experiments clearly demonstrate, that there are no pre-existing germs, and that the generation of animals and vegetables is not univocal. There are, perhaps, as many beings, which either live or vegetate, produced by a fortuitous assemblage of organic particles, as by a constant and successive generation. It is to such productions that we ought to apply the axiom of the ancients, *Corruptio unius, generatio alterius*. The corruption and resolution of animals and vegetables produce an infinite variety of organized bodies: Some of them, as those of the calmar, are only a kind of machines, which, though exceedingly simple, are very active. Others, as the spermatic animalcules, seem to imitate the movements of animals. Others resemble vegetables in their manner of growth and expansion. There are others, as those of blighted wheat, which, at pleasure, can be made alternately to live or to die; and it is difficult to know to what they should be compared. There are still others, and in great numbers, which are at first a kind of vegetables, then become a species of animals, and again return alternately to their vegetable state. The more we examine this species of organized bodies, we shall probably discover greater and more singular varieties of them, in proportion as they are

are farther removed from our observation, and from the structure of other animals with which we are already acquainted.

For example, blighted corn, which is effected by an alteration or resolution of the organic substance of the grain, is composed of multitudes of small organized bodies resembling eels. When infused in water for ten or twelve hours, we discover them to have a distinct wreathing, and a small degree of progressive motion. They cease to move as soon as the water fails them ; and their motion commences upon the addition of fresh water. This alternate death and revivification may be repeated for months, and even for years ; so that these small machines may be made to act as long and as often as we please, without destroying or diminishing their force. They are a species of machines, which begin to act whenever they are immersed in a fluid. These filaments sometimes open like the filaments of the semen, and produce moving globules : We may, therefore, conclude them to be of the same nature, except that they are more fixed and solid.

The eels in paste have no other origin than the union of the organic particles of the most essential parts of the grain. The first eels which appear are certainly not produced by other eels ; but, though they are not propagated themselves, they fail not to engender other living eels. By cutting them with the point of a lancet, we dis-

cover

cover smaller eels issuing in great numbers out of their bodies. The body of this animal seems to be only a sheath or sac containing a multitude of smaller animals, which perhaps are other sheaths of the same kind, in which the organic matter is assimilated into the form of eels.

A great number of experiments would still be necessary to distinguish these animals, which are so singular and so little understood, into classes and genera. Some of them may be regarded as real zoophytes, which enjoy a kind of vegetation, and which, at the same time, seem to wreath and move like animals. Others appear, at first, to be animals, and then join and form a species of vegetables. A small attention to the resolution of a single grain of corn will elucidate, at least in part, what I have said on this subject. I might add other examples ; but those I have given were only produced for the purpose of exhibiting the varieties of generation. There are unquestionably several organized bodies which we consider as real animals, but which are not engendered by others of the same species. Some of them are only a kind of machines ; and some of these machines have a certain limited effect, and act for a certain time only, as the machines in the milt of the calmar ; others may be made to act as long and as often as we please, as those of blighted grain. There are vegetables which produce animated bodies, as the filaments of the human semen, from which active globules issue and

and move by their own powers. In the corruption, the fermentation, or rather in the resolution of animal or vegetable substances, we find real animals capable of propagating their species, though they were not themselves produced in this manner. These varieties are, perhaps, more extensive than we imagine. Though it be right to generalize our ideas, to assemble the effects of Nature under one point of view, and to class her productions; yet numberless shades, and even degrees, in the great scale of being, will always escape our observation.

C H A P.

C H A P. X.

Of the Formation of the Foetus.

FROM the experiments of Verheyen, who found the semen of the bull in the uterus of a cow, and from those of Ruysch, Fallopius, and Leeuwenhoek, who discovered male semen in the uteri of women and many other animals, it seems to be a point fully ascertained, that the semen of the male enters into the uterus of the female. It is probable, that, during the time of coition, the orifice of the uterus opens for the reception of the seminal fluid: But, though this should not happen, the active and prolific part of the semen may penetrate the membranes and substance of the uterus itself; for, as the seminal liquor, as formerly remarked, is almost entirely composed of organic particles, which are very active, and extremely minute, they may pass with the utmost facility through the membranes and substance of the uterus.

What proves that the active part of this fluid may pass through the pores and substance of the uterus, is the sudden change it undergoes immediately after conception. The menses are obstructed,

obstructed, the uterus becomes flaccid, swells, and appears to be inflated. All these changes must be effected by an active external cause, by the penetration of part of the seminal fluid into the substance of the uterus. This penetration is not confined to the surface; it extends through all the vessels and parts of which the uterus is composed, like that penetration by which nutrition, and the expansion of the body, is produced.

We shall the more easily believe this to be the case, when we reflect, that, during the time of gestation, the uterus not only augments in size, but even in its quantity of matter, and that it possesses a species of life, or rather of vegetation, which continues till the child be delivered. If the uterus were only a sac, a reservoir for receiving the semen and retaining the foetus, it would extend and diminish in thickness, in proportion as the foetus grew larger. But the augmentation of the uterus is not a simple extension or dilatation of its parts. It not only extends as the foetus enlarges, but it acquires, at the same time, an additional thickness and solidity; or, in other words, both its size and quantity of matter are greatly increased. This augmentation is a real growth or increase of substance, similar to the expansion of the body in young animals, which could not be effected but by an intimate penetration of organic particles analogous to the substance of those parts. As this

expansion

expansion of the uterus never happens but after impregnation, the seminal liquor must be the cause by which it is produced; for the uterus is considerably augmented before the foetus has acquired bulk enough to dilate it by pressing against its internal surface.

It appears, from my own experiments, to be equally certain, that the female has a seminal fluid, which begins to be formed in the testicles, and is brought to maturity in the glandulous bodies. This fluid perpetually distills through the small apertures in the extremities of these bodies, and, like that of the male, enters the uterus by two different ways, either through the apertures at the extremities of the horns of the uterus, or by piercing through the substance of the uterus itself.

These two seminal fluids are extracts from all parts of the body; and a mixture of them is all that is necessary for the formation of a certain number of males and females. The more any animal abounds in this seminal fluid, or the more it abounds in organic particles, the number of young is the greater, as may be remarked in the smaller animals; and the number of young diminishes in proportion as the organic particles are less abundant, as is the case with the larger animals.

But, before taking any farther notice of other animals, we shall examine with attention the formation of the human foetus. In mankind, as well as in the larger species of animals, the

quantity of organic particles in the male and female semen is not great, and, accordingly, they very seldom produce above one foetus at a time. This foetus is either a male or a female, according as the number of organic particles predominates in the male or in the female fluid; and the child resembles the father or the mother most, according to the proportional quantities of male or female organic particles in the mixture of the two liquors.

I conceive, therefore, that the seminal fluids, both of the male and of the female, are equally active, and equally necessary for the purposes of propagation: And this, I think, is fully proved by my experiments; for I found in both fluids the same moving bodies; I discovered that the male fluid enters the uterus, where it meets with the fluid of the female; that these two fluids are perfectly analogous; and that they are composed of parts not only similar in their form, but in their action and movements *. Now, I imagine, that, by the mixture of the two fluids, the activity of the organic particles proper to each is stopped; that the action of the one counterbalances the action of the other; that each organic particle, by ceasing to move, remains fixed in the place which corresponds to its nature; and that this place can be no other than that which it formerly occupied in the body of the animal from which it was extracted. Thus all the organic particles which were detached from the head

* See, Chap. VI.

of the animal, will arrange themselves in a similar order in the head of the foetus. Those which proceeded from the back bone, will dispose themselves in an order corresponding to the structure and position of the vertebrae. In the same manner, the organic particles which had been detached from any part of the body, will naturally assume the same position, and arrange themselves in the same order that they observed before they were separated from that part. Of course, these particles will necessarily form a small organized body, entirely similar to the animal from which they originally proceeded.

It is worthy of remark, that this mixture of the organic particles of both sexes contains particles which are similar, and particles which are dissimilar. The similar particles are those which have been detached from all the parts that are common to the two sexes. The dissimilar particles are those which have been separated from the parts that distinguish the two sexes. In this mixture, therefore, there is a double portion of particles destined for the formation of the head, the heart, and such parts as are common to both sexes; while there are no more than what are necessary for the production of the sexual parts. Now, the similar particles may act upon each other without producing any disorder; and they may unite in the same manner as if they had proceeded from the same body. But the dissimilar parts cannot act upon each other, nor form any intimate union, because they have no analogy or relation: Hence

these particles will preserve their original nature without any mixture, and fix their position, without the necessity of being penetrated by others. Thus the particles which proceed from the sexual parts will be first fixed, and those that are common to the two sexes, whether they belong to the male or to the female, will then fix indiscriminately, and form an organized body, which, in its sexual parts, will perfectly resemble the father, if it be a male, and the mother, if it be a female, but which, in the other parts, may resemble either or both.

If what I have advanced be properly understood, we shall, perhaps, be able to obviate an objection to the system of Aristotle, and which might also be urged against the doctrine which I am now establishing. The objection is, Why is not every individual, both male and female, endowed with the faculty of producing an animal of its own sex? I am aware of the difficulty of solving this question, which I have slightly mentioned in the fifth chapter, and shall now proceed farther to illustrate.

From what is delivered in the first four chapters, and from the experiments I have related, it is apparent, that reproduction is effected by the assemblage and union of the organic particles, detached from every part of the animal or vegetable body, in one or several common reservoirs; that these particles are the same which serve for the nutrition and expansion of the body;

body; and that both effects are produced by the same matter, and by the same laws. I think I have established this point by so many facts and reasonings, that it is impossible to entertain a doubt concerning its truth. But I allow, that the question may be put, Why every separate animal and vegetable produces not its own likeness, since every individual detaches from all its parts, and collects, in a common reservoir, the organic particles necessary for the formation of a small organized body? Why is not this organized body formed? and why, in most animals, is a mixture of the fluids of both sexes necessary? If I were to reply, that, in all the vegetable tribes, in all those animals that multiply by cuttings, and in the vine-fretters, which produce without any sexual commerce, the general intention of Nature seems to be, that each individual should multiply its own species, and that reproduction by the intervention of sexes is only an exception to this general law. It might, with propriety, be rejoined, that the exception is perhaps more universal than the rule itself. To maintain that all individuals would have the faculty of reproducing, if they were endowed with proper organs, and if they contained the matter necessary for nourishing the embryo, is not removing the difficulty: For, in females, all these circumstances concur; and yet the influence of the male is indispensable to the production either of a female or of a male foetus.

But, we come nearer a solution of the question, when we maintain, that, though the fluid in the testicles and seminal vessels of the male contain all the organic particles necessary for the formation of a male foetus, yet these particles cannot receive any local establishment or arrangement of parts, because a constant circulation of them goes on by means of absorption, and by the perpetual succession of new supplies from all parts of the body; and that, as the same circulation of the organic particles takes place in the female, neither of them can possibly multiply without the assistance of the other; because, in the mixture of the male and female fluids, the different organic particles of which they consist have a greater affinity to each other than they have to the body of the female where the mixture happens. But, though this explication were admitted, why, it may still be asked, does not the ordinary mode of generation correspond with it? For, upon this supposition, each individual would produce, and, like snails, mutually impregnate one another, every individual receiving the organic particles furnished by the other, which, without being injured by any foreign power, would unite solely by the affinity between the particles themselves. If there were no other cause by which the organic particles could be united, perhaps this mode of generation would be the most simple. But it is contrary to the analogy of Nature.

Few

Few animals are endowed, like snails, with both sexes; and, therefore, if this mode of propagating were the most simple, it would be more generally employed by Nature. This solution, of course, amounts to no more than a gratuitous supposition, that males produce not, solely because they have not organs proper for containing and nourishing a foetus.

It may be still farther supposed, that the activity of the organic particles in the semen of each individual requires to be counterbalanced by the force or action of those of the other individual, in order to reduce them to a fixed state, or equilibrium, without which the formation of the foetus cannot be effected; and that the motion of the organic particles of the female cannot be counterbalanced by any other cause than a contrary action in the organic particles received from the male. But this answer is too general to be void of obscurity. However, when we attend to all the phaenomena, it may, perhaps, admit of some illustration. The mixture of the two seminal fluids produces not only a male or female foetus, but other organized bodies, which are endowed with the faculty of growth or expansion. The placenta, the membranes, &c. are produced at the same time, if not sooner, than the foetus. There are, therefore, in the seminal fluid of the male or female, or in the mixture of both, organic particles not only suited to the production of the foetus, but of the placenta

placenta and membranes. Since there are no parts either in the male or female bodies from which they could be detached, whence do these particles proceed? It must be admitted, that the organic seminal particles of each sex being equally active, uniformly produce organized bodies every time that they can fix themselves, by their mutual action upon one another; that, of the particles destined to produce a male, those peculiar to the male sex will fix first, and form the sexual parts; that the particles common to both sexes may afterwards fix themselves indifferently, in order to form the rest of the body; and that the placenta and membranes are produced by the excess of organic particles which have not been employed in the formation of the foetus. If, as we have supposed, the foetus be a male, all the organic particles peculiar to the female sex, which have not been employed, as also the superfluous particles of both individuals which have not entered into the composition of the foetus, and which cannot be less than one half of the whole, remain for the formation of the membranes and placenta. If the foetus be a female, the same quantity of superfluous organic particles still remain, and are occupied in forming the placenta and membranes.

But it may be said, that the membranes and placenta, upon this supposition, ought to become another foetus, which would be a male, if the first was a female, and a female, if the first was

a male ; because the first foetus consumed only the organic particles peculiar to the sex of one individual, and the half of those particles which were common to both sexes ; and, of course, the sexual particles of the other individual, and the other half of the common particles, remain still unexhausted. To this I reply, that the first union of the organic particles prevents a second, at least under the same form ; and that the foetus, being first formed, exerts an external force, which destroys the natural arrangement of the other organic particles, and throws them into that order which is necessary for the formation of the placenta and membranes.

From the experiments and observations formerly made, it is apparent, that all animated beings contain an amazing quantity of living organic particles. The life of an animal or vegetable seems to be nothing else than a result of all the particular *lives* (if the expression be admissible) of each of these active particles, whose life is primitive, and perhaps indistructible. These living particles we have found in every animal and vegetable substance ; and we are certain, that all these particles are equally necessary to the nutrition, and, consequently, to the reproduction of animals and vegetables. That the union of a certain number of these particles, therefore, should produce an animated being, it is not difficult to conceive. As each particle is animated, a whole, or any assemblage of them,

must

must be endowed with life. These living organic particles being common to all animated beings, they are capable of forming particular species of animals or of vegetables, according to the peculiar arrangement they assume. Now, this arrangement depends entirely on the form of the individuals which furnish the organic particles. If they are furnished by an animal, they arrange themselves under the form peculiar to its species, exactly agreeable to that arrangement they observed when they nourished or expanded the animal itself. But, does not this regular arrangement suppose the necessity of some base or centre, round which the particles assemble in order to unite and form a foetus ? This basis is furnished by the particles which form the sexual parts. I shall illustrate this point.

As long as the organic particles of either sex remain alone, their activity produces no effect, because it is not opposed by any resistance or reaction from particles of a different kind. But, when the male and female liquors are blended, the particles detached from the sexual parts, being of a different kind, serve as a base to fix the activity of the other particles.

Upon this supposition, that the organic particles which, in the mixture of the two fluids, represent the sexual parts of the male, can alone serve as a basis to the particles which proceed from all parts of the female ; and that those proceeding from all parts of the male can only be

be fixed by the particles which are detached from the sexual parts of the female ; we may conclude, that the sexual parts of the male foetus are formed by the organic particles of the father, and the rest of its body by the organic particles of the female ; and, on the contrary, that the female foetus derives nothing but its sex from the mother, and the rest of its body from the father. Boys, therefore, except in the parts which distinguish their sex, ought to resemble the mother more than the father, and girls should resemble the father more than the mother.

Considering generation by sexes under this light, we should conclude it to be the most common manner of reproduction, as it is in reality. Beings of the most perfect organization, as animals, whose bodies make a whole that is incapable of division, and whose powers are all concentrated into one point, cannot be reproduced in any other way ; because they contain only particles that are perfectly similar, and cannot be united but by means of different particles furnished by another individual. But vegetables, which are less perfect in their organization, and which can be divided without destruction, are capable of being reproduced in different ways :
1. Because they contain dissimilar particles ;
2. Because the form of these bodies is less fixed and determined than that of an animal, different parts may supply the functions of each other,

ther, and vary according to circumstances: The roots of a tree, when exposed to the air, push out branches and leaves; and thus the organic particles of vegetables obtain a local establishment, become fixed, and produce individuals in many different ways.

The same phaenomenon is exhibited in animals whose organization is less perfect, as in the fresh water polypus, and others, which are capable of reproducing by the division of their parts. These organized bodies, instead of single animals, may be considered as bundles of organized beings united by a common membrane, as trees are composed of an infinite number of minute trees *. The vine-fretters, which propagate individually, likewise contain dissimilar particles; because, after producing their young, they change into barren flies. Snails mutually communicate dissimilar particles to each other; and, therefore, each individual is fruitful. Thus, in every mode of generation with which we are acquainted, we find, that the necessary union of the organic particles cannot be effected but by the admixture of different particles, to serve as a common basis, and to fix or destroy their activity.

According to this general idea of sexes, we may suppose, that the distinction of sex extends through all Nature; for *sex*, in this sense, is nothing but that part of bodies which furnishes organic

* See Chap. II.

organic particles of a different kind from those of the common parts, and which serve as a basis for their union. But it is, perhaps, useless to reason on a question which can be solved at once, by saying, that, as God has created sexes, animals must necessarily be produced by their intervention. We are not in a condition, as I formerly remarked, to explain *why* things exist; we are unable to explain *why* Nature almost universally employs sexes for the reproduction of animals, or *why* sexes exist. We ought, therefore, to content ourselves with reasoning concerning things as they are. If we attempt to rise higher, we lose ourselves in the regions of fancy, and forget the narrow limits of our capacity.

Leaving, therefore, all further subtleties, I shall adhere to nothing that is not founded on facts and observation. I find that the reproduction of bodies is effected in many different modes: But, at the same time, I clearly perceive, that animals and vegetables are reproduced by the union of the organic particles detached from all parts of their bodies. I am certain that these active organic particles exist in the seeds of vegetables, and in the seminal fluids of animals, both male and female; and have no doubt that every species of reproduction is accomplished by the union and admixture of these particles. It is equally unquestionable, that, in the generation of man, and other animals, the organic particles

particles of the male and female mix at the time of conception ; because we often see children who resemble both father and mother : And, what confirms this theory is, that all the particles common to the two sexes mix together promiscuously, but that the particles peculiar to the sexes never mix ; for we daily perceive children with eyes resembling those of the father, while their mouth and front resemble those of the mother. But we never see any such mixture of resemblances in the sexual parts ; we never find, in the same individual, the testicles of the father and the vagina of the mother.

The formation of the foetus, therefore, is effected by the mixture of the organic particles of both sexes ; and this mixture fixes or gives a local establishment to the particles, because it is made according to the laws of affinity which take place between the different parts, and which determine the particles to arrange themselves in the same order they observed when they existed in the individuals who furnished them. The particles which proceed from the head, for example, cannot, according to these laws, take up their station in the legs, or in any other part but the head of the foetus. All the particles are in motion when they first unite ; and this motion must be round the point or centre of union. This basis or central point, which is necessary to the union of the particles, and which, by its reaction and inertia, fixes and destroys their activity,

tivity, is probably the first assemblage of particles that proceed from the sexual parts, because they are the only particles in the mixture which differ from those common to both sexes.

I imagine, therefore, that, in the mixture of the two fluids, the organic particles which come from the sexual parts of the male fix themselves first, and cannot unite with those which proceed from the sexual parts of the female, because they are of a different nature, and have less affinity to each other than the particles that come from the eye, the arm, or any other part of the female. Round this centre, or point of union, the other organic particles successively arrange themselves in the same order they formerly existed in the body from which they were derived; and, according as the particles of the one or of the other individual most abound, or are nearer this central point, they enter in greater or less quantities into the composition of the new being, which, in this manner, is formed in the middle of a homogeneous fluid; at the same time, vessels begin to shoot, which increase in proportion to the growth of the foetus, and furnish it with proper nourishment. These vessels, which have a peculiar species of organization, are probably formed by the excess of the organic particles that have not been admitted into the composition of the foetus; for, as these particles are both active, and furnished with a base or point of union from the organic particles peculiar

liar to the sexual parts of the other individual, they must arrange themselves in the form of an organized body, but not in the form of another foetus; because their position with respect to each other has been changed by the different movements of the particles which entered into the composition of the first foetus. From the union of these superabundant particles, therefore, an irregular body must arise, which will resemble the foetus in nothing but its growth and expansion, because, though this body be composed of the same organic active particles with the foetus, their position and form must be different, as they were thrown aside from the centre or point of union, which served as a basis for the formation of the foetus.

When the quantity of seminal fluid of both individuals is great, or, rather, when these liquors abound with organic particles, different centres of attraction are formed in different parts of the mixture; and, in that case, by a mechanism similar to what has been mentioned above, several foetuses are formed, some of them males, and others females, according as the particles of the one sex or of the other are most active. But, from the same centre of attraction, two foetuses can never originate; because two centres are requisite for this purpose. Besides, if this arrangement were to happen, no particles would be left for the formation of the placenta and membranes; because they would all be employed in constituting the

second foetus, which would necessarily be a female, if the other was a male. All that could happen in a case of this kind would be, that some of the particles common to both individuals, being equally attracted by the first centre of union; must arrive there at the same time, and produce a monster, or a foetus with superfluous parts; or, if some of the common particles should fix at too great a distance from the first centre, or be constrained by the attraction of the second, round which the placenta is formed, a monster, defective in some part, would be the consequence.

That the organic particles peculiar to the sexual parts serve for a basis or centre of union to the other particles of which the embryo is formed, I pretend not to demonstrate: But, as they are the only particles which differ from the rest, it is more natural to imagine that they should answer this purpose than those which are common to both individuals.

I formerly detected the errors of those who maintained, that the heart, or the blood, were first formed. The whole is formed at the same time. We learn from actual observation, that the chicken exists in the egg before incubation. The head, the back-bone, and even the appendages which form the placenta, are all distinguishable. I have opened a great number of eggs, both before and after incubation, and I am convinced, from the evidence of my own eyes, that the whole chicken exists, in the middle of the

cicatrice, the moment the egg issues from the body of the hen. The heat communicated to it by incubation, expands the parts only, by putting the fluids in motion. But we have never been able to determine, with certainty, what parts of the foetus are first fixed, at the moment of its formation.

I have always maintained, that the organic particles were fixed, and that they united in consequence of their motion being suspended. Of the truth of this fact I am fully convinced; for, if the male and female semen be separately examined, we find in both a great number of moving particles; but, when these fluids are mixed, the motion of the particles is totally destroyed, and a certain degree of heat is necessary to renew their activity; for the chicken, which exists in the centre of the cicatrice, has no motion before incubation; and, even 24 hours, or two days afterwards, when we begin to perceive it without the microscope, it has not the smallest appearance of motion. During the first two or three days, the foetus is only a small white mucilaginous mass, which gradually acquires consistence and magnitude. But this progress is exceedingly slow, and has no resemblance to the rapid movements of the organic particles in the seminal fluid. Besides, I maintained, not without reason, that the motion of the organic particles was entirely destroyed; for, if eggs be kept without exposing them to the degree of heat

heat that is necessary for the expansion of the chicken, the embryo, though completely formed, will remain without any motion; and the organic particles of which it is composed will continue fixed, without being able to give life and motion to the embryo which was formed by their union. Thus, after the motion of the organic particles is stopped, and after they have united in such a manner as to form a foetus, some external cause is still necessary to give them life and motion. This cause, or agent, is heat, which by rarifying the fluids, obliges them to circulate: This circulation makes all the organs act; and nothing farther is necessary for the growth and expansion of the parts than the continuation of this heat.

Before the action of this external heat, there is not the smallest appearance of blood; and I never could perceive any change of colour in the vessels till about 24 hours after incubation. In the vessels of the placenta, which communicate with the body of the foetus, the blood first appears. But it would seem that this blood loses its red colour, as it approaches the body of the animal; for the chicken is entirely white; and, during the first, second, and third days after incubation, we can with difficulty perceive a few red particles near the animal's body, but which seem not to make any part of it, though these red particles are destined for the formation of the heart. Thus the formation of blood is an effect produced by the motion communicated

to the fluids by heat; and even this blood is formed without the body of the animal, the whole substance of which consists of a white mucilage.

The foetus, as well as the placenta, receive the nourishment that is necessary for their expansion by a species of absorption; and they assimilate the organic particles of the liquor in which they swim: For, it is an equal impropriety to say that the placenta nourishes the animal, as that the animal nourishes the placenta. If the placenta nourishes the foetus, the former would diminish in proportion to the growth of the latter, which by no means happens; for both augment together. I have indeed observed, that, in eggs, the placenta at first grows much more in proportion than the foetus, and, consequently, it may nourish the animal; or, rather, it conveys nourishment to the chick by means of absorption.

What we have said concerning the chicken, admits of an easy application to the human foetus, which is formed by the union of the organic particles of the two sexes. The membranes and placenta are produced by the superabundant particles that enter not into the composition of the foetus, which is now inclosed in a double membrane, containing also a quantity of fluid. This fluid is at first perhaps, nothing but a portion of the seminal liquors of the father and mother; and, as the foetus is not thrown out of the uterus, it enjoys, from the moment of its formation,

tion; as much external heat as is sufficient for its expansion. This heat communicates motion to the fluids; it gives play to all the organs; and the blood is formed in the placenta, and in the body of the foetus, solely by the motion excited by the heat. We might even maintain, that the formation of the blood in a child is as independent of the mother, as that which arises in the egg is independent of the hen that covers it, or of the furnace which heats it.

It is certain that the foetus, the membranes, and the placenta, are all nourished and expanded by absorption; for, at first, the sac that contains the whole product of generation does not adhere to the uterus: And we have seen, from the experiments of De Graaff upon female rabbits, that he made the globules which contained the foetuses roll about in the uterus. They could receive no nourishment, therefore, but by absorbing the fluids that constantly bedew the uterus, to which they afterwards begin to adhere by means of a mucilage that gradually gives origin to small blood vessels, as shall afterwards be more fully explained.

But, to return to the formation of the foetus, concerning which we have to make several remarks, both as to its situation, and to the different circumstances that may prevent or alter the mode of its production.

In the human species, the semen of the male enters into the uterus, the cavity of which is

T 3 considerable.

considerable ; and, when it meets with a sufficient quantity of female semen, the two instantly mix, and the organic particles unite and form the foetus. The whole is, perhaps, performed in a moment, especially if the two fluids be in an active state. The cavity of the uterus is the proper place for the formation of the foetus ; because the semen of the male has an easier admission into the uterus than into the Fallopian tubes or ovarium ; and, as the uterus has only a small aperture, which is always shut, except when opened by the ardor of love, the materials of generation remain there in safety, unless they be disturbed by some rare and accidental circumstance. But, as the male fluid moistens the vagina, before it penetrates the uterus, and, as the organic particles are exceedingly active, it may penetrate as far as the Fallopian tubes and ovarium. In the same manner, as the female fluid is already perfected in the glandulous bodies of the testicles, from which it distills and moistens the Fallopian tubes, before it descends into the uterus ; and, as it may escape through the lacunae round the neck of the uterus, it is not impossible that the mixture of the two liquors may take place in all these different places. Foetuses, therefore, may frequently be formed in the vagina, and instantly fall out of it, having nothing proper for their retention. They may also be sometimes formed in the Fallopian

Iopian tubes ; but instances of this kind must be rare.

Anatomists mention, that foetuses have been found, not only in the Fallopian tubes, but likewise in the ovaria. M. Theroude *, a surgeon in Paris, showed to the academy a rude mass which he found in the right ovarium of a girl of 18 years of age. Two open fissures, garnished with hair like the eye-lids, were perceived in this mass. Above these eye-lids was a kind of front, with a black line in place of eye-brows. Immediately above the front, there were several hairs collected into two separate pencils, one of them about seven inches long, and the other three. Below the angle of the eye, two large, hard, white, dentes molares appeared, together with their gums : These teeth were about three lines long, and about a line distant from each other. Several other teeth appeared, situated at different distances. In the same volume †, M. Mery is reported to have found in the ovarium of a woman an upper jaw-bone, with several teeth in it, so perfect that they appeared to be at least of ten years growth. In the Medical Journal, published by the Abbe de la Roque ‡, we have the history of a woman, who died of her ninth child, which had been formed *in* or *near* one of the ovaria ; for, from the description, it is not clear whether the child was within the ovarium,

* See mem. de l'acad. des sciences, tom. 2. p. 91.

† P. 244. ‡ January 1683.

varium, or adjacent to it only. This foetus was about an inch thick, and completely formed. In the Philosophical Transactions, examples are recorded of teeth, hair, and bones being found in the ovaria of women. If all these facts can be credited, the seminal liquor of the male must be supposed sometimes, though rarely, to mount up to the ovaria. But there are many considerations which render this point extremely doubtful : 1. The facts which seem to support it are few : 2. The only instance of a perfect foetus found in the ovary, is narrated in a very suspicious manner by M. Littré. Neither is it impossible that the seminal fluid of the female alone may sometimes produce organized masses, as moles, cists full of hair, of bones, or of flesh. Besides, if we are to believe anatomists, foetuses may be formed in the testicles of men as well as in those of women ; for, we are told by a surgeon, in the 2d volume of the history of the old academy *, that he found a foetus, with its membranes, in which the head, the feet, the eyes, the bones and cartilages, were distinguishable, in the scrotum of a man. Were all these facts equally worthy of credit, we must necessarily adopt one of the two following hypotheses ; either that the seminal fluid of each sex can produce nothing without being mixed with the other ; or, that either of the fluids alone is capable of producing irregularly organized masses. If we maintain the former

mer hypothesis, to explain the facts above related, we shall be obliged to admit, that the male fluid sometimes ascends to the ovary, and, by mixing there with the female fluid, forms organized bodies; and also, that the female fluid, by being copiously effused in the vagina, may, in the time of coition, penetrate as far as the scrotum of the male, in the same manner as the venereal virus often reaches that part; and, consequently, that an organized body may be formed in the scrotum by a mixture of the male and female fluids. If the other hypothesis, which is the most probable, be adopted, namely, that the seminal fluid of each individual may separately produce organized masses, then all these osseous, fleshy, and hairy bodies, which sometimes appear in the ovaria of females, and in the scrotum of males, may derive their origin from the seminal fluid of the individual in which they are found. But it is needless to speculate farther concerning facts which seem to be more uncertain than inexplicable; for I am inclined to think, that the seminal fluid of each individual may singly produce something; and that young girls, for example, may produce moles, without any intercourse with the male, in the same manner as hens lay eggs without the intervention of the cock. I might support this opinion with observations equally credible as those we have just now quoted. M. de la Saone, a physician and anatomist, published a treatise on this subject, in which

which he assures us, that nuns, though strictly cloistered, sometimes produce moles: And why should this be impossible, since hens produce eggs without any communication with the cock, and since we find, in the cicatrices of these eggs, instead of a chicken, a mole with its appendages? The analogy here is sufficiently strong to make us at least suspend a rash determination. Whatever be in this, it is certain, that a mixture of the two fluids is necessary for the formation of a foetus, and that this mixture cannot be properly effected but in the uterus, or in the Fallopian tubes, where anatomists have sometimes discovered foetuses: And it is natural to imagine, that those which have been found in the cavity of the abdomen, have escaped by the extremity of the tube, or by some accidental rupture of the uterus; and that they never fall into the abdomen from the ovary, because I think it next to impossible that the seminal fluid should ascend so far. Leeuwenhoek has computed the motion of his pretended spermatic animals to be four or five inches in 40 minutes; so that, if the whole fluid moved at this rate, in an hour or two the animalcules might proceed from the vagina into the uterus, from the uterus into the Fallopian tubes, and from the Fallopian tubes into the ovaria. But, how is it possible to conceive, that the organic particles, whose motion ceases whenever they are deprived of the fluid part of the semen, should arrive at the ovary,

unless

unless they were accompanied with the liquor in which they swim? The moving particles cannot give a progressive motion to the fluid which contains them. Thus, whatever activity may be ascribed to these organic particles, we cannot conceive how they should arrive at the ovary, and there form a foetus, unless, by some unknown power, the fluid be absorbed by the ovary, a supposition which is not only gratuitous, but contrary to probability.

The difficulty attending this supposition confirms the opinion, that the male fluid enters the uterus, either by its orifice, or by penetrating its substance. The female fluid may likewise find its way into the uterus, either by the aperture at the extremity of the Fallopian tubes, or by penetrating the substance of the tubes and uterus. M. Weitbrech, an able anatomist of the Academy of Petersburg, has clearly proved that the seminal fluid can penetrate through the substance of the uterus: 'Res omni attentione dignissima,' says he, 'oblata mihi est in utero foeminae alicujus a me dissectae; erat uterus ea magnitudine qua esse solet in virginibus, tubaeque ambae apertae quidem ad ingressum uteri, ita ut ex hoc in illas cum specillo facile possem transfire ac flatum injicere, sed in tubarum extremo nulla dabatur apertura, nullus aditus; fimbriarum enim ne vestigium quidem aderat, sed loco illarum bulbus aliquis pyriformis materia subalbida fluida turgens, in cuius medio fibra plana nervea,

‘ nervea, cicatriculae aemula, apparebat, quae
‘ sub ligamentuli specie usque ad ovarij involu-
‘ cra protendebatur.

‘ Dices, eadem a Regnero de Graaff jam
‘ olim notata. Equidem non negaverim illus-
‘ trem hunc professorem, in libro suo de organis
‘ mulieribus, non modo similem tubam deline-
‘ asse, Tab. xix. fig. 3. sed et monuisse ‘ tubas,
‘ quamvis, secundum ordinariam naturae dis-
‘ positionem, in extremitate sua notabilem sem-
‘ per coarctationem habeant, praeter naturam
‘ tamen aliquando claudi;’ verum enim vero,
‘ cum non meminerit auctor an id in utraque
‘ tuba ita deprehenderit, an in virgine, an status
‘ iste praeternaturalis sterilitatem inducat, an
‘ vero conceptio nihilominus fieri possit, an a
‘ principio vitae talis structura suam originem
‘ ducat, sive an tractu temporis ita degenerare
‘ tubae possint, facile perspicimus multa nobis
‘ relicta esse problemata, quae, utcumque soluta,
‘ multum negotii facescant in exemplo nostro.
‘ Erat enim haec foemina maritata, viginti qua-
‘ tuor annos nata, quae filium pepererat quem
‘ vidi ipse, octo jam annos natum. Dic igitur
‘ tubas ab incunabulis clausas sterilitatem indu-
‘ cere: Quare haec nostra foemina peperit?
‘ Dic concepisse tubis clausis: Quomodo ovu-
‘ lum ingredi tubam potuit? Dic coaluisse tubas
‘ post partum: Quomodo id nosti? quomodo
‘ adeo evanescere in utroque latere fimbriae pos-
‘ sunt, tanquam nunquam adfuissent? Si qui-
‘ dem

dem ex ovario ad tubas alia daretur via, praeter illarum orificium, unico gressu omnes superarentur difficultates; sed fictiones intellectum quidem adjuvant, rei veritatem non demonstrant; praestat igitur ignorationem fateri, quam speculationibus indulgere *. These difficulties, which occurred to this acute observer, are insurmountable, according to the egg-system. But the fact he records is alone sufficient to demonstrate, that the female fluid may penetrate the substance of the uterus; and it is not to be doubted that the male fluid is capable of entering it in the same manner. The change which the male fluid produces in the uterus, and the species of vegetation or expansion which it occasions in that viscus, is sufficient to demonstrate the truth of the fact. Besides, the fluid which issues through the lacunae of De Graaff being of the same nature with that of the glandulous bodies, it is evident that this liquor proceeds from the ovaria; and yet there are no vessels through which it could pass. We must therefore conclude, that it penetrates through the spongy substance of the parts, and that it not only enters the uterus, but may even issue out of it, when the parts are irritated.

But, though this penetration should be regarded as impossible, it cannot be denied, that the female fluid, which distills from the glandulous

* See Comm. Acad. Petropol. vol. iv. pag. 261. and 262.

lous bodies of the ovaria, may fall into the uterus, by entering the apertures at the extremities of the Fallopian tubes, as the male fluid enters by the orifice of the uterus itself; and, consequently, that the foetus may be formed in the cavity of the uterus, by the mixture of the two fluids, in the manner already explained.

C H A P.

C H A P. XI.

Of the Expansion, Growth, and Delivery of the Foetus, &c.

IN the expansion of the foetus, two different species of growth are distinguishable: The first, which immediately succeeds the formation of the foetus, is not uniform in all the parts of the animal. The nearer the foetus approaches to maturity, the growth of the parts is more proportional; and it is not till after the birth, that all the parts grow nearly in an equable manner. We must not imagine, that the foetus, at the time of its formation, has the exact figure of an adult. The small embryo, it is true, contains all the parts essential to a man; but they differ in their successive expansion.

In an organized body, like that of an animal, some parts may be supposed to be more essential than others; and though none of them are useless or superfluous, yet there are some to which others seem to owe their growth and disposition. Some parts may be considered as fundamental, without which the animal could not exist, and others as only superficial and accessory. The latter

latter seem to derive their origin from the former, and to be intended more for conferring symmetry and external ornament on the animal, than for enabling it to exist, or to perform the functions essential to life. These two different species of parts, are successively expanded, and are almost equally apparent at the time of birth. But there are other parts, as the teeth, which arrive not at full maturity till several years after; and others, as the glandulous bodies in the female testicles, the beard of males, &c. which appear not till the age of puberty.

To discover the fundamental and essential parts of an animal body, attention must be had to the number, situation, and nature of the whole. Those which are simple, those whose position is invariable, and those without which the animal cannot exist, must necessarily be the most essential. Those, on the contrary, which are double, or more numerous, those which vary in size and position, and those which may be taken away without injuring or killing the creature, may be regarded as less essential, or more accessory to the animal machine. Aristotle mentions, that the only parts essential to all animals are those with which they take and digest their nourishment, and throw out the superfluous part of it from the body. The whole intestinal canal is indeed extremely simple, and no other part can supply its place. The head and back-bone are likewise simple parts, the position

sition of which is invariable. The back-bone is the foundation of the animal frame; and the action and movements of most members of the body depend upon the spinal marrow which that bone contains. It is this part, also, together with the head, which appears first in the embryo. Now, these simple parts, which are first formed, are all essential to the existence and the form of the animal.

The double parts in an animal body are more numerous than the single parts; and they seem to be produced on each side of the single parts by a species of vegetation; for the double parts are similar in form, and different only in position. The left hand is perfectly similar to the right; but, if the left hand were placed in the situation of the right, we could not perform the same actions with it. The same thing may be observed of all the double parts: They are similar in form, but differ in position, which is relative to the body of the particular animal; and, if a line were drawn, dividing the body into two equal parts, the position of all the similar parts would tend to this line as to a centre.

The spinal marrow, and the vertebrae in which it is inclosed, appear to be the real axis of all the double parts of the animal body, from which they seem to derive their origin, and to be only proportional branches issuing from this trunk or common base; for, in the young chick, we see the ribs shooting from each side of the

vertebrae, as the small branches shoot out from the principal branch of a tree. In all embryos, the middle of the head and the vertebrae first appear; we then see, on each side of the vesicle which composes the middle of the head, two other vesicles which seem to proceed from the first: These two vesicles contain the eyes, and the other double parts of the head. In the same manner, we perceive an equal number of small tubercles issuing from each side of the vertebrae, which gradually extend, and form the ribs, and other double parts of the trunk. Lastly, the arms and legs appear like small tubercles on each side of the trunk. This first growth is very different from what afterwards takes place: It is the production of parts which appear for the first time; the growth which succeeds is only an expansion of parts already formed.

The order and symmetry of the double parts in all animals, their regular position, the equality of their extension and growth, and the perfect similarity of their structure, seem to indicate, that they derive their origin from the single parts; that a certain force resides in the single parts which acts equally on each side; or, which amounts to the same, they are the bases or fulcra against which the action of those powers that produce the expansion of the double parts is exerted; and that the action of these forces, both on the right and left sides, are precisely equal, and counterbalance each other.

Hence

Hence we may conclude, that, if there is any defect, or redundancy, in the matter destined for the formation of the double parts, as the forces are equal on each side, this defect or excess must take place both in the right and left sides. If, for example, from a defect of matter, a man has but two fingers in the right hand, in place of five, the same defect will appear in the left; if, from an excess of matter, there be six fingers in the right hand, he will have the same number in the left; or, if the matter be vitiated; and produces a change in the parts of one side; the same change will appear in the other. Of this fact we have daily proofs: The parts of monsters are always deranged in a certain order and proportion. Hence Nature, even in her errors, uniformly commits the least of possible mistakes.

This harmony in the position of the double parts of animals, is likewise apparent in vegetables. The branches push out small ramifications on each side; the small nerves in the leaves are equally disposed with regard to the principal nerve; and, if the symmetry appears to be less exact in vegetables than in animals; this proceeds only from its being more various, and less precise. But the same order is easily recognisable; and the single and essential parts are perfectly distinct from those which are double;

and it is evident, that the latter derive their origin from the former.

It is impossible to determine the form of these double parts before their expansion, or in what manner they are complicated, or what figure results from their position in relation to the single parts. The body of an animal, at the instant of its formation, unquestionably contains all the parts of which it ought to be composed: But the relative disposition of these parts is then very different from what afterwards appears. If we examine the expansion of a young leaf of a tree, we will find that it is plaited on each side of the principal nerve; and that its figure, at this time, has no resemblance to that which it afterwards assumes. When we amuse ourselves with plaiting paper, in order to give it the form of a crown, of a boat, &c. the different plaits of the paper seem to have no resemblance to the figure which results from their expansion: We only perceive that the plaits are uniformly made in a certain order and proportion, and that, whatever is done on one side, is also done on the other. But, to determine the figures which may result from the expansion of any given number of folds, is a problem beyond the powers of geometry. The science of mathematics reaches not what immediately depends upon position. Leibnitz's art of *Analysis situs* does not yet exist; though the art of knowing the relations that result from the position

tion of things would be, perhaps, more useful than that which has magnitude only for its object; for we have more occasion to be acquainted with form than with matter.

In the expansion of natural productions, the folded or plaited parts not only assume different positions, but they acquire, at the same time, extension and solidity. Since, therefore, we are unable to ascertain the exact result of a simple expansion of a folded figure, in which, as in folded paper, nothing takes place but a change of position among the parts, without any augmentation or diminution of the quantity of matter, how is it possible for us to judge concerning the expansion of the compound body of an animal, in which not only the relative position, but likewise the quantity of matter in these parts, suffer considerable changes? We can only reason, therefore, on this subject, by drawing conclusions from the examination of objects at different periods of their expansion.

We, indeed, perceive the chick in the egg before incubation: It swims in a transparent fluid, contained in a small purse formed by a very fine membrane in the centre of the cicatrice. But the chick is then only a particle of inanimated matter, in which no organization or determined figure can be distinguished. We can perceive, however, that one of its extremities is the head, and the other the back-bone. The embryo, in this state, seems to be the first pro-

duct of fecundation, resulting from the mixture of the male and female semen. To ascertain this fact, several things require attention: When the hen has, for some days, been along with the cock, and afterwards separated from him, the eggs produced 20 days or a month after this separation, are equally fertile as those laid during her cohabitation with the male. The eggs produced at the end of this period require only the usual time of 21 days in hatching; and their embryos are equally advanced both in form and consistence. From this circumstance we might be led to imagine, that the form in which the embryo appears before incubation, is not the immediate effect of the mixture of the two seminal fluids, but that it existed in different forms during the abode of the egg in the body of the mother; for the embryo, in the form in which we see it before incubation, requires only the aid of heat in order to bring it to maturity. Now, if this form of the embryo had existed 21 days or a month before, when the egg was first impregnated, why was it not hatched by the internal heat of the mother? Why do we not find the chick completely formed in those eggs which have been impregnated 21 days before they are laid?

But this difficulty, though seemingly great, is not insurmountable. When the hen cohabits with the cock, the cicatrice of each egg, which contains the semen of the female, receives a small quantity

quantity of the male fluid. The eggs in the ovarium of oviparous females are analogous to the glandulous bodies in the testicles of the viviparous: The cicatrice of the egg corresponds to the cavity of those glandulous bodies which contain the female semen; and that of the male penetrates and mixes with it. The formation of the embryo instantly results from this mixture or union of the two fluids. The first egg laid by the hen after her communication with the cock is fecundated, and capable of being hatched. Those which she is afterwards to lay were all impregnated at the same instant: But, as they want some essential parts, the production of which has no dependence on the male fluid; as they have neither the white, the membranes, nor the shell, the small embryos contained in the cicatrices of these imperfect eggs, are incapable of being hatched, though aided by the internal heat of the mother. The embryo, therefore, remains in the cicatrice in the same state in which it was first formed, till the egg acquires all the parts necessary to the growth and nourishment of the foetus; and it is not till after the egg has arrived at full perfection, that the expansion of the embryo commences. This expansion is effected by the external heat of incubation: But it is unquestionable, that, if the egg could be retained in the body 21 days after it was completely formed, the chick would be hatched, unless the internal heat of the mother

were

were too great; for the degrees of heat necessary for hatching eggs are very limited; and the least excess or defect is equally fatal to this operation. The last eggs, therefore, laid by the hen, containing the embryos in the same state as the first, prove nothing more than the necessity of their acquiring full perfection before they can be hatched.

It is apparent, therefore, that the state of the embryo when the egg is laid by the hen, is its first state, and that which immediately succeeds impregnation; that it undergoes no intermediate changes of form; and, consequently, by tracing, as Malpighius has done, its gradual expansion, hour after hour, we discover every thing that it is possible for us to know, unless we could perceive the mixture of the two fluids, and the manner in which the particles arrange themselves during the first formation of the embryo.

If we reflect on this instantaneous fecundation of a number of eggs, which are to be laid at successive intervals, we shall discover a new argument against the existence of eggs in viviparous animals: For, if women contained eggs, like hens, why are not many of them fecundated at the same time? Why does not one impregnation give birth to a successive race of children? And, when women conceive two or three children, why do they always come into the world at the same time? If these foetuses were produced from eggs,

eggs, would they not succeed each other according to the different states of perfection of the several eggs existing at the time of impregnation? And would not superfoetations be as frequent as they are rare, and as natural as they are accidental?

It is impossible to trace the gradual expansion of the human foetus, as we can that of the chick in the egg. The opportunities for observation are few; and all we know of this subject is derived from the writings of anatomists, surgeons, and accoucheurs. It is from collecting all their particular observations, and comparing their remarks with their descriptions, that the following abridged history of the human foetus has been compiled.

Immediately after the mixture of the two seminal fluids, it is probable that the whole materials of generation exist in the uterus, under the form of a small globe; for we learn from anatomists, that, three or four days after conception, there is a small globular mass in the uterus, the greatest diameter of which is about 6 lines, and the least 4. This globe is formed by a delicate membrane, which contains a limpid liquor very like the white of an egg. We may already perceive, in this liquor, some small fibres, which are the first rudiments of the foetus. Upon the surface of the globe there is a network of delicate fibres, which extends from one

of the extremities to the middle: These are the first vestiges of the placenta.

Seven days after conception, the lineaments of the foetus are distinguishable by the naked eye. They are, however, very imperfect, and have the appearance of a gelly almost transparent, though it has acquired some degree of solidity. The head and trunk may be easily distinguished; because this mass is of an oblong figure, and the trunk is longest and most delicate. Some small fibres, resembling a plume of feathers, issue from the middle of the foetus, and terminate in the membrane in which it is inclosed. These fibres are the rudiments of the umbilical cord.

Fifteen days after conception, the head and the most prominent features of the face are apparent. The nose resembles a small elevated thread perpendicular to a line which marks the division of the lips: Two small black points represent the eyes; and we see two holes in place of ears. The body of the foetus has also acquired some growth. On each side of the superior and inferior parts of the trunk, those small protuberances appear, which are the rudiments of the arms and legs. The length of the whole body is about five French lines.

Eight days after, in all three weeks, the body of the foetus is augmented only about a line: But the arms and legs are apparent. The growth of the arms is quicker than that of the legs;

legs; and the fingers separate sooner than the toes. The internal organization now begins to be visible: The bones appear like fine threads. The ribs are disposed on each side of the backbone like minute threads: The arms, the legs, the fingers and toes, are also represented by similar threads.

At one month, the foetus is more than an inch in length: It naturally assumes a curved posture in the middle of the liquor that surrounds it; and the membranes in which the whole is included, are both augmented and thickened. The whole mass is of an oval figure, the greatest diameter of which is about an inch and a half, and the least about an inch and a quarter. The human figure is no longer equivocal: All the parts of the face are already distinguishable; the body is delineated; the haunches and the belly are prominent; the hands and legs are formed, and their fingers and toes are divided; the skin is thin and transparent; the viscera resemble a knot or plexus of fibres; the vessels are like fine threads, and the membranes are extremely delicate: The bones are still soft, and it is in a few places only that they have begun to assume some degree of solidity. The vessels which form the umbilical cord lie parallel to each other in a straight line. The placenta now occupies only a third of the whole mass, instead of a half, which it did during the first days; the superficial growth of the placenta, therefore,

therefore, has not been so great as that of the foetus and mass; but it has received a great augmentation in solidity; it has become proportionally thicker than the membranes of the foetus, both of which are now distinguishable.

According to Hippocrates, the male foetus expands sooner than the female.

At the end of six weeks, the foetus is about two inches long, and the human form begins to be more perfect, only the head is very large in proportion to the other parts of the body. About this time the motion of the heart becomes visible: In 50 days, the heart has been perceived to beat for a considerable time after the foetus was extracted from the uterus.

In two months, the foetus is more than two inches in length; and the ossification is perceptible in the middle of the two arm-bones, in the thigh and leg, and in the point of the under jaw, which is then greatly advanced before the upper. These, however, are only osseous points. But, by means of a quicker growth, the clavicles are entirely ossified: The umbilical cord is formed, and the vessels which compose it begin to twist like the threads of a rope: But this cord is very short in comparison of the length it afterwards acquires.

In three months the foetus is nearly three inches long, and weighs about three ounces. Hippocrates asserts, that at this time the motions of the male foetus begin to be felt by the mother;

ther; but that those of the female are not perceptible till four months. Some women, however, affirm that they have felt the motions of the foetus at the beginning of the second month. It is difficult to acquire any certain knowledge on this subject: The sensations excited by the first movements of the foetus depend more, perhaps, on the sensibility of the mother, than the strength of the child.

Four months and a half after conception, the length of the foetus is from six to seven inches. All the parts are greatly augmented, and easily distinguishable from each other: Even the nails appear on the fingers and toes. The testicles of the male are shut up in the belly above the kidneys. The stomach is filled with a thick fluid, similar to that which is contained in the amnios. In the small guts we find a milky fluid, and a black liquid matter in the great guts. There is a small quantity of bile in the vesica fellis, and a little urine in the bladder. As the foetus floats freely in the fluid that surrounds it, there is always some space between its body and the membranes in which it is contained. These membranes, at first, grow more rapidly than the foetus; but, after a certain time, the reverse takes place. Before the end of the third month, the head is bent forward; the chin rests on the breast; the knees are elevated, and the legs folded back upon the thighs. One of the hands, and often both, touch the face. Afterwards,

when

when the foetus acquires more strength, it perpetually changes its position, as we learn from the following observations made by persons skilled in the art of midwifery: 1. The umbilical cord is often twisted round the body and members of the child, in a manner that necessarily supposes different motions and positions. 2. Mothers feel the motion of the child sometimes on one side of the uterus, and sometimes on the other; and it often strikes against many different places, which could not happen unless it assumed different positions. 3. As the foetus swims in a fluid which surrounds it on all sides, it may easily turn, extend, and twist itself by its own powers: It must likewise take different situations, according to the various attitudes of the mother's body; when the mother, for example, lies down, the position of the foetus must differ from what it is when she stands.

Most anatomists maintain, that the foetus is obliged to bend its body, because it is too much confined by the membranes. But this opinion seems not to be well founded; for, during the first five or six months, at least, there is room more than sufficient to admit a full extension of the foetus; and yet, during all this period, the foetus is bended. We see likewise that the chick is bended in the liquor of the amnios, while, at the same time, this membrane, and the fluid it contains, afford room sufficient to hold a body five or six times larger than the foetus. We

may,

may, therefore, conclude, that the bended posture of the foetus is natural, and not the effect of restraint. I am inclined to think, with Harvey, that the foetus takes this posture, because it is most favourable to rest and sleep; for all animals bend their bodies when they want to repose themselves, or to sleep: And, as the foetus sleeps almost continually, it naturally assumes this advantageous position. 'Certe,' says this celebrated anatomist, 'animalia omnia, dum
' quiescunt et dormiunt, membra sua ut pluri-
' muin adducunt et complicant, figuramque o-
' valem ac conglobatam quaerunt: Ita pariter
' embryones, qui aetatem suam maxime somno
' transfigunt, membra sua positione ea qua plas-
' mantur (tanquam naturalissima ac maxime in-
' dolenti quietique aptissima) componunt*.'

The uterus, as formerly remarked, grows very quickly after pregnancy; and it continues to increase proportionally with the foetus. But the growth of the foetus at last exceeds that of the uterus; and it is natural to think, that the foetus, when near maturity, is too much confined, and agitates the uterus by repeated motions. The mother feels these successive efforts, which are called periodic pains, after the labour of child-bearing commences. The more force the foetus exerts in order to dilate the uterus, it finds an increased resistance from the natural elasticity of the parts. Hence every effort

* Harvey de Generat. p. 257.

fort tends to open the os tincae, or orifice of the uterus, which has already been gradually enlarged during the last months of pregnancy. The head of the foetus pushes along against the margins of this orifice, and dilates it by a constant pressure, till the moment of delivery, when it opens so wide as to allow a free passage to the child.

What renders it probable that the labour-pains are occasioned by the dilatation of the os tincae is, that this dilatation is the only certain mode of distinguishing the real from the false pains. Women often feel very brisk pains, which are not those that immediately precede delivery. To distinguish those false from the true pains, Deventer advises the accoucheur to feel the orifice of the uterus, and maintains, that, if the pains be true, the dilatation will augment upon the accession of every pain ; and that, on the contrary, if the pains be false, the orifice will rather contract than dilate, or, at least, that it will not continue to dilate. Hence we may conclude, that these pains proceed not from a forced dilatation of the orifice of the uterus. The only thing that is embarrassing, is the alternation of pain and of ease experienced by the mother. This circumstance does not perfectly correspond with the cause we have assigned ; for the gradual and continued dilatation of an orifice should produce a constant pain, without any intervals of ease. Perhaps the alternations

may

may be ascribed to to the separation of the placenta: It adheres to the uterus by the insertions of a number of small papillæ. May we not, therefore, suppose that these papillæ separate not from their cavities all at once; and that the successive separation of these papillæ gives rise, at different intervals, to the fresh accessions of pains? Here the effect perfectly corresponds with the cause; and this conjecture may be supported by another remark: Immediately before delivery, there issues out a viscous whitish liquor, similar to that which flows from the papillæ of the placenta, when torn from the uterus. It is therefore extremely probable, that this liquor, which issues from the uterus, is produced by the separation of some of the papillæ of the placenta.

It sometimes happens, that the foetus escapes from the uterus without bursting the membranes, and, consequently, without discharging the liquor they contain. This species of birth seems to be the most natural, and is similar to that of most animals. The human foetus, however, commonly pierces the membranes, by the resistance it meets with at the orifice of the uterus: And sometimes a part of the amnios, and even of the chorion, is brought away adhering to the head of the child like a cap. As soon as the membranes are pierced or torn, the liquor, which is called the *waters*, runs out, and, by lubricating the vagina and orifice of the uterus, facilitates the passage of the child. After the

discharge of the waters, there is sufficient room left in the uterus for the midwife to return the child, when its position is unfavourable to the birth. After the child comes into the world, the delivery is not completed. The placenta and membranes still remain in the uterus ; and the child is attached to them by means of the umbilical cord : They are easily brought away by the hand of the midwife ; and sometimes the weight of the child is sufficient. These organs, which were necessary to the existence of the foetus, become useless, and even noxious to the child, after birth. They are, therefore, instantly disengaged from the child's body, by casting a knot on the umbilical cord, about an inch from the navel, and by cutting the cord an inch above the ligature. In six or seven days, the remains of the cord dry up, and fall off close to the navel.

By examining the foetus before birth, we are enabled to form some ideas concerning the mechanism of its natural functions. There are organs necessary to it while in the womb of the mother, but which become useless immediately after birth. The better to comprehend these functions, we must explain more fully the nature of these accessory parts, the umbilical cord, the membranes, with the liquor they contain, and the placenta. The umbilical cord, which is attached to the body of the foetus at the navel, is composed of two arteries and a vein : By

these

these the course of the circulation is lengthened; but the vein is larger than the arteries. At the extremity of the cord, each of these vessels divide into an infinite number of ramifications, and extend themselves between two membranes. They set off from the common trunk in such a manner, that the whole ramifications assume a round form, and are distinguished by the name of placenta, because they resemble a cake. The central part of the placenta is thicker than its edges: Its mean thickness is about an inch, and its diameter is eight or nine inches, and sometimes more. Its external surface, which is applied to the uterus, is convex, and the internal surface is concave. The blood of the foetus circulates in the cord and in the placenta. The arteries of the cord proceed from two large arteries in the foetus, and carry the blood through all the arterial ramifications of the placenta; and the blood is collected and returned to the foetus by the venous branches of the placenta and the umbilical vein.

The concave surface of the placenta is covered with the chorion: Its convex surface is also covered with a soft membrane, which seems to be a continuation of the chorion, and is easily torn; and the foetus is inclosed in the double covering of the chorion and amnios. The figure of the whole is globular, because the intervals between the foetus and membranes are filled with a transparent fluid. This liquor is imme-

diateley confined by the amnios, which is the internal membrane: It is thin and transparent, and folds itself round the umbilical cord, at its insertion into the placenta, and continues to cover it the whole way to the navel of the foetus. The chorion is the external membrane; it is thick, spongy, and interspersed with blood-vessels. It consists of several coats, the outermost of which covers the convex surface of the placenta. It sends off duplicatures to cover the papillae, which are inserted into the cavities at the fundus of the uterus, called *lacunae*. These insertions connect the foetus to the uterus.

Some anatomists have maintained, that the human foetus, like those of certain quadrupeds, was furnished with an *allantois*, a membrane destined for the reception of the urine; and they have pretended to have discovered it between the chorion and amnios, or in the middle of the placenta, at the root of the umbilical cord, under the form of a pretty large bladder; and that it received the urine by means of a long tube, which made a part of the cord, and which opened at one end into the bladder, and, at the other, into the allantois, answering the same purposes as the urachus in other animals. They acknowledge, however, that the urachus of the human foetus is not near so large as in quadrupeds; but they assert that it is divided into a number of small tubes, and that the urine passes into their cavities.

To

To these facts are opposed the experience and observation of most anatomists. They seldom find any vestiges of an allantois either between the chorion and amnios, or in the placenta; nor do they perceive any urachus in the umbilical cord. A kind of ligament, indeed, runs from the external surface of the bottom of the bladder to the navel; but, when entering the cord, it becomes so delicate as to be almost reduced to nothing. Neither is this ligament commonly hollow; and we can perceive no corresponding aperture in the bottom of the bladder.

The foetus has no communication with the open air; and the experiments made upon the lungs demonstrate that they have never respired; for they sink in water, while those of infants, who have breathed, uniformly swim: The foetus, therefore, has no respiration in the womb of the mother; consequently, it can make no sound with its voice; and all the stories of children groaning and crying before birth must be regarded as fabulous. After the waters run off, however, the air may find admission into the cavity of the uterus, and the child may begin to respire before its birth. In this case, the child may cry, in the same manner as the chicken cries before the shell of the egg is broken, which it is enabled to do by means of the air lodged in a cavity between the external membrane and the shell: This air exists in all eggs,

and is produced by the fermentation of the matters they contain *.

The lungs of the foetus, having no motion, receive no more blood than is sufficient for their nourishment and growth: Another passage, therefore, is open for its circulation. The blood in the right auricle of the heart, instead of passing into the pulmonary artery, and, after circulating through the lungs, returning into the left auricle by the pulmonary vein, passes directly from the right to the left auricle, through an aperture called the *foramen ovale*, which is in the partition of the heart that separates the two auricles: The blood then enters the aorta, by the ramifications of which it is distributed to every part of the body; it is then taken up by the numerous branches of the veins, which gradually unite into one trunk, called the *vena cava*, that terminates in the right auricle of the heart. The blood contained in this auricle does not all pass through the foramen ovale; part of it escapes into the pulmonary artery, but it enters not into the body of the lungs; for there is a communication between the pulmonary artery and the aorta, by an arterial canal which leads immediately from the one to the other. It is by these means that the blood circulates in the foetus, without entering the lungs, which it does in children, in adults, and in all animals who respire.

It

* See Vegetable Statics, chap. 6.

It has been imagined by some, that the blood of the mother passes into the body of the foetus, by means of the placenta and umbilical cord: They supposed, that the blood-vessels of the uterus opened into the lacunae, and those of the placenta into the papillæ, and that they inosculated with one another. But this opinion is contradicted by experiment. When the arteries of the umbilical cord are injected, the liquor returns by the veins, without any of it escaping externally. Besides, the papillæ can be drawn out of the lacunæ in which they are lodged, without any extravasation of blood either from the uterus or placenta; from both there oozes out a milky matter, which, we have already remarked, serves for the nourishment of the foetus. It is probable that this liquor enters the veins of the placenta in the same manner as the chyle enters the subclavian vein; and the placenta, perhaps, performs the office of the lungs in maturing the blood. One thing is certain, that the blood appears much sooner in the placenta than in the foetus; and I have often observed, in eggs which had been sat upon for a day or two, that the blood appeared first in the membranes, and that their blood-vessels are numerous and large, while the whole body of the foetus, except the point where these blood-vessels terminate, is only a white transparent matter, in which there is not the least vestige of blood.

It has been imagined that the liquor of the amnios is a nourishment received by the mouth of the foetus. Some have even pretended to have found this liquor in the stomach, and to have seen several foetuses who wanted the umbilical cord entirely, and others who had only a small portion of it, which had no connection with the placenta. But, in this case, may not the liquor have passed into the body of the foetus by the portion of the cord that remained, or even by the navel itself? Besides, other facts may be opposed to these: Foetuses have been found, whose lips were not separated; and others whose oesophagus had no aperture. To reconcile these facts, some anatomists have maintained, that the aliment passed into the foetus partly by the umbilical cord, and partly by the mouth. But none of these opinions seem to have any foundation. The question is not, how the foetus alone, but how the whole apparatus of generation, receive their growth and nourishment? for the placenta, the liquor, and the membranes, increase in bulk as well as the foetus; and, consequently, those instruments and canals employed for receiving and transporting nourishment to the foetus, are themselves endowed with a species of life. The expansion of the placenta and membranes is equally difficult to conceive as that of the foetus; and, it may be said, with equal propriety, that the foetus nourishes the placenta, as that the placenta nourishes

nourishes the foetus. At the commencement of growth, the whole mass floats in the uterus, without any adhesion; and, of course, the nourishment can only be conveyed by an absorption of the lacteous fluid contained in the uterus. The placenta appears first to attract this fluid, which it converts into blood, and transports by the veins into the foetus. The *liquor amnii* seems to be nothing but this milky fluid in a purified state, the quantity of which is augmented, by a similar absorption, in proportion to the growth of the membranes; and the foetus probably absorbs this liquor, which seems to be necessary for its growth and nourishment: For, it is worthy of remark, that the foetus, during the first two or three months, contains very little blood: It is as white as ivory, and appears like a congeries of lymph somewhat consolidated; and, as the skin is transparent, and all the parts extremely soft, the body of the foetus may be easily penetrated by the fluid in which it swims, and thus receive the matter necessary for its growth and expansion. It may indeed be supposed that the foetus afterwards receives nourishment by the mouth; because we find a liquor, similar to that of the amnios, in the stomach, urine in the bladder, and meconium, or excrement, in the intestines; and, as neither urine nor meconium appear in the amnios, it is natural to conclude, that no excrements are voided by the foetus, especially as some are born without having the

anus

anus perforated, and yet large quantities of meconium are found in their intestines.

Though the foetus has no immediate connection with the uterus, but is only attached to it by the small external papillæ of the placenta; though it has no communication with the blood of the mother, but, in some measure, is equally independent of her as the egg is independent of the hen which covers it; yet it has been maintained, that, whatever affects the mother, produces a similar effect upon the foetus, and that the impressions received by the former are communicated to the sensormium of the latter. To this imaginary influence have been attributed all those resemblances, monstrosities, and peculiar marks which appear on the skin of particular children. Many of these marks I have examined, and they uniformly appeared to be occasioned by a derangement in the texture of the skin only. Every mark must necessarily have a faint resemblance to something or other: But such resemblances, I am persuaded, depend more on the imagination of those who see them, than upon that of the mother. On this subject, the marvellous has been pushed to an extreme degree. The foetus has not only been said to bear the real representations of the appetites of the mother, but that, by a singular sympathy, the marks which represent strawberries, cherries, &c. assumed a deeper colour during the season of these fruits. A little attention, however, will convince

convince us, that these changes of colour are more frequent, and that they happen whenever the motion of the blood is accelerated, whether it be occasioned by the heat of summer, or by any other cause. The marks are always either yellow, or red, or black; because the blood gives these colours to the skin when it enters in too great quantities into the vessels. If these marks were occasioned by the appetites of the mother, why are not their forms and colours as various as the objects of her desires? What a multitude of strange figures would be exhibited, if all the whimsical longings of a mother were written upon the skin of the child?

As our sensations have no resemblance to the objects which excite them, it is impossible that desire, fear, horror, or any other passion or emotion, can produce real representations of the objects by which they are occasioned. An infant being, in this respect, equally independent of the mother as the egg is independent of the hen that sits upon it, I should be equally induced to believe that the imagination of a hen, which saw by accident a cock's neck twisted, should produce wry necked chickens from the eggs she was hatching, as that a woman that saw a man broke upon the wheel, should produce, by the mere force of imagination, a child with all its limbs broken.

But, supposing this fact to be well attested, I still maintain that the imagination of the mother could

could not be the cause of it: For, what is the effect of horror? An internal movement, or, if you please, a convulsion of the mother's body, which might alternately compress and stretch the uterus. What would be the result of this commotion? Nothing similar to its cause; for, if the commotion was very violent, the foetus might be killed, wounded, or have some of its parts deranged: But how is it possible to imagine that this commotion should produce in the foetus any thing similar to the thoughts of the mother, unless we suppose, with Harvey, that the uterus possesses the faculty of conceiving ideas, and of realising them upon the foetus?

But, if the imagination of the mother has no effect upon the foetus, it may still be demanded, Why did this child come into the world with its members broken? Though a direct solution of a fact, which is both extraordinary and uncertain, is not to be expected; yet, I think, this question admits of a satisfactory answer. Phænomena of the most uncommon kind, and which are but rarely exhibited, as necessarily happen as those that are usual and frequent. Among the infinite combinations of which matter is capable of forming, arrangements of the most peculiar and extraordinary species must sometimes take place. Hence, out of the numberless children which daily come into the world, one may sometimes appear with two heads, with four legs, or with all its members broken. It is, therefore,

therefore, within the circle of nature, that a child, without the aid of the mother's imagination, may be born with its arms and legs broken. This phaenomenon may have been exhibited oftener than once; the mother of this child may, during her pregnancy, have seen a man broken on the wheel; and the defects of conformation in the child may have been attributed to the impulse made, by this dreadful spectacle, upon the imagination of the woman. But, independent of this general solution, the fact may be explained in a more direct manner. The foetus, as formerly remarked, has nothing in common with the mother. Its functions, its organs, its blood, its movements, are all peculiar, and belong to itself alone. The only matter it derives from the mother, is the liquor or nutritive lymph which distills from the uterus. If this lymph suffers any change, if it be infected with the venereal virus, the infant is affected with the same disease; and it is reasonable to think that all the diseases which proceed from vitiated humours may be communicated from the mother to the child. We know that the small pox is communicated in this manner; and we have too many examples of children, immediately after birth, becoming innocent victims of the debauchery of their parents. The venereal virus attacks the most solid parts of the bones; and it appears to act with more force upon the middle of the bones, which is the part where the ossification

ossification first commences, and is, of course, the most hard and solid part. I conceive, therefore, that the infant in question has been affected with the venereal disorder while in the womb of its mother, and that this was the reason why it came into the world with its bones broken through the middle.

The same effect might be produced by the rickets: In the royal cabinet, there is a skeleton of a rickety child, the bones of whose legs and arms are joined in the middle by a callus: From inspecting this skeleton, it appears that its bones had been broken before birth, and afterwards reunited by a callus.

But we have dwelt too long upon a fact which credulity alone has rendered marvellous. Prejudice, especially that species of it which is founded in wonder, will always triumph over reason. It is needless to attempt to persuade women that the marks on their children have no connection with their ungratified longings. I have sometimes asked them, before the birth of a child, of what particular longings they had been disappointed, and, of course, what marks the child would bear? But I had only the satisfaction of perplexing, without convincing them.

The time of gestation is generally about nine months, but it is sometimes longer and sometimes shorter. Many children are born in the seventh and eighth, and some not till after the ninth month: But, in general, the births before the

the ninth month are more frequent than those which exceed that term.

It is generally believed, that children born in the eighth month cannot live, or, at least, that more of them die than of those who come into the world in the seventh month. This opinion appears to be paradoxical ; and, if we consult experience, I believe it will be found to be erroneous. A child born in the eighth month is more perfectly formed, and consequently more vigorous and lively, than one who is born in the seventh. This opinion, however, is very commonly received, and is founded on the authority of Aristotle : ‘ *Caeteris animantibus ferendi uteri unum est tempus, homini vero plura sunt ; quippe et septimo mense et decimo nascitur, atque etiam inter septimum et decimum positis ; qui enim mense octavo nascuntur, etsi minus, tamen vivere possunt* *.’ The beginning of the seventh month is the earliest term of delivery. If the foetus be rejected sooner, it dies, and is denominated an abortion. Thus the time of gestation is more various in the human species than in other animals ; for it extends from the 7th to the 10th, and, perhaps, to the eleventh month.

We are assured by women who have had many children, that females remain longer in the womb than males. If this be true, it is not surprising that female children should sometimes be born

* *Vide de Generat. anim. l. 4. c. ult.*

born in the 10th month. When infants come into the world before the 9th month, they are neither so large nor so well formed as those who appear not till a later period. Those, on the contrary, who remain in the womb till the 10th month, are larger and better made ; their hair is longer ; the growth of the teeth, though still concealed within the gums, is more advanced ; and the tone of their voice is deeper and more distinct.

With regard to the occasional causes of delivery, there is much uncertainty. It is imagined by some writers, that, when the foetus has acquired a certain size, the capacity of the uterus becomes too small for its retention, and that the restraint felt by the child obliges it to exert every effort to break its prison. Others alledge, which amounts nearly to the same thing, that the foetus becomes too heavy to be supported by the uterus, which, therefore, opens to be discharged of its load. Neither of these reasons appear to be satisfactory : The uterus has always sufficient capacity and strength to contain and support the weight of a child of nine months ; for it is often loaded with two, during the same period ; and it is certain, that the weight and size of two children of eight months, for example, exceed those of a single infant of the same age. Besides, it is not unfrequent that a child of nine months is less than another at eight months, though it still remains in the womb.

Galen

Galen pretends that the foetus continues in the uterus till it is able to take nourishment by the mouth, and that the want of proper food makes it restless, and anxious to escape. It has been said by others, that the foetus is originally nourished by the mouth, but that, in process of time, the liquor amnii is so contaminated with the urine and transpiration of the foetus, that it becomes perfectly disgusting, and obliges the child to use every method to effect its escape from the womb.

These reasons seem not to be more satisfactory than the former ; for from them it would follow, that the smallest and weakest foetuses would necessarily remain longer in the womb than those of larger and more robust bodies ; which is by no means the case. Besides, it is not for nourishment that the child, immediately after birth, seems to be anxious ; for it can want food for a considerable time after : It appears, on the contrary, to be extremely desirous of easing itself of the superfluous load of nourishment (the meconium) received in the womb. This circumstance induced Drelincourt, and some other anatomists, to think, that the acrimony and uneasiness, arising from an accumulation of excrement in the bowels, is the reason why they become restless, and use every effort to escape from the womb. I am not, I acknowledge, more satisfied with this explication than

the others. If the child is pressed with faeces, why does it not evacuate them in the liquor amnii? But this never happens. It appears, on the contrary, that the necessity of evacuating the meconium is not felt till after birth, when the motion of the diaphragm, occasioned by respiration, compresses the intestines, and gives rise to this evacuation; especially since no meconium was found in the amnios of a foetus of ten months, who had not respiration, and since an infant of six or seven months discharges the meconium soon after respiration.

Other anatomists, and particularly Fabricius ab Aquapendente, imagined that the foetus left the uterus, from a desire of being refreshed by respiration. But this cause seems to be as chimerical as any that has been mentioned. It is impossible that a foetus can have any idea of respiration; and far less can it have any conception whether respiration would be agreeable or disagreeable.

After considering all these hypotheses, I suspect that the delivery of the foetus depends on a cause of a very different nature. The menstrual flux returns at stated intervals. Though its appearance be interrupted by impregnation, its cause is not destroyed; and, though no blood is exhibited at the accustomed period, yet a revolution in the system, similar to what happens before impregnation, must take place. It is for this

this reason, that, in some women, the menses are not entirely suppressed during the first two or three months after conception. I imagine, therefore, that this periodic revolution happens as regularly after a woman has conceived as before, but that the blood is prevented from flowing, because the excretaries of the uterus are swelled and shut up, unless when it arrives in such large quantities, and acts with such force, as to overcome the resistance with which it is opposed. In this case, a great quantity of blood rushes out, and an abortion is the consequence. But it frequently happens, that a small quantity of blood appears, without producing this effect; because the blood has only been able to open a few of the canals or excretaries of the uterus, while the rest remain entirely obstructed.

Though no blood appears, which is generally the case, the first revolution fails not to be accompanied with the same painful symptoms. During the first suppression of the menses, therefore, the uterus is affected with a considerable agitation, which, when a little augmented, entirely destroys the product of generation. Hence we may reasonably conclude, that few of those conceptions, which happen a short time before the accustomed return of the menses, are successful; because the action of the menstrual blood easily destroys the feeble roots of a germ so tender and so delicate. Those conceptions, on the contrary, which take place immediately

after this periodic discharge, succeed much better ; because the foetus is allowed more time to grow, and to fortify itself against the action of the blood, when the next revolution happens in the system.

After the foetus has been enabled to resist the action of the first revolution, the increase of its growth, and of its attachment to the uterus, render it still more capable of resisting any of the subsequent revolutions: Abortions, indeed, sometimes happen during every revolution ; but they are more rare in the middle of the period of gestation than either at the beginning or near the end. Why they are more frequent at the beginning, has already been explained : It only remains to show why they are likewise more frequent towards the end.

The foetus generally comes into the world during the tenth revolution of the menses. When it is born at the ninth or eighth, it lives, and is not, therefore, regarded as an abortion. Some have pretended to have seen instances of children born at the seventh, and even at the sixth revolution, who, notwithstanding this unfavourable circumstance, continued to live. There is no difference between abortion and birth, but what relates to the living powers of the child. In general, the number of abortions in the first, second, and third months, for the reasons already assigned, is very great ; and the number of premature births, in the seventh and eighth months,

is also very great, in proportion to the abortions in the fourth, fifth, and sixth months; because, during this middle term of gestation, the product of generation having acquired strength and solidity sufficient to resist the action of the first four periodic revolutions, a more violent effort than any of the former is necessary to destroy the foetus. For the same reason, an abortion is more difficult during the fifth and sixth months. But the foetus, which till now was weak, and could exert its own force only in a feeble manner, begins to move with more vigour; and, when the eighth revolution takes place, the efforts of the foetus uniting with those of the uterus, and facilitating its exclusion, the foetus may come into the world in the seventh month, and be in a capacity of living, whenever it happens to be unusually strong at this period. But, if the foetus be excluded solely from a weakness of the uterus, which renders it unable to resist the action of the blood during the eighth revolution, the birth of it is considered as an abortion, and the child dies. But such cases are uncommon; for, if the foetus has resisted the first seven revolutions, nothing but particular accidents can prevent it from resisting the eighth, unless it has acquired more vigour than is common at this period. A foetus which has acquired the same degree of strength, but at a later period, will be excluded at the ninth revolution; and those which require nine months in obtaining this degree of

strength, will be born at the tenth revolution, which is the most usual term. But, when the foetus acquires not this degree of strength and perfection in nine months, it will remain in the uterus till the eleventh, or even the twelfth revolution, that is, till the tenth or eleventh month: Of such late births many examples are recorded.

Other reasons, to confirm the opinion, that the menstrual flux is the occasional cause of births at different periods, may be produced. The females of all animals which have no menses bring forth very nearly at the same terms: The difference in the times of gestation is extremely small. We may, therefore, conclude, that this variation, which is very great in women, proceeds from the action of the menstrual blood, which is exerted at every periodic revolution.

We have already remarked, that the placenta adheres to the uterus by the papillæ only; that there is no blood either in these papillæ, or in the lacunæ in which they are inserted; and that, when they are separated, an operation which requires no great effort, a milky liquor only issues from them. Why, therefore, is the birth of a child uniformly followed by a considerable haemorrhage, first of pure blood, and afterwards of blood mixed with a watery fluid? This blood proceeds not from the separation of the placenta; for the papillæ are drawn out of the lacunæ

without

without any effusion of blood. Delivery, therefore, which is nothing more than this separation, ought to produce no haemorrhage. Is it not more natural, on the contrary, to think, that the action of the blood is the cause of the birth; and that it is this menstrual blood alone which forces the vessels of the empty uterus, and begins to flow immediately after delivery, in the same manner as it did before conception?

We know, that, for some time after conception, the sac which contains the product of generation, adheres not to the uterus. We have seen, from the experiments of De Graaff, that, by blowing upon the small globule, it changes its position. The adhesion to the uterus is never very strong: In the early periods of gestation, the placenta is slightly applied to the uterus; and these parts are only contiguous, or joined by a mucilaginous matter, which has hardly any adhesion. How, then, should it happen, that, in abortions of the first or second month, this globule never escapes without being attended with a great effusion of blood? This effusion cannot be occasioned by the passage of the globule, which has no adhesion to the uterus. It is by the action of the blood, on the contrary, that the globule is extruded. Should we not, therefore, conclude, that this is the menstrual blood, which, by forcing the canals through which it was accustomed to flow before impregnation,

nation, destroys the product of conception, and resumes its ordinary course?

The pains of child-bearing are principally occasioned by this action of the blood; for, it is well known, that they are equally violent in abortions of two or three months, as in ordinary births; and that many women feel, without having conceived, very acute pains, whenever the menstrual flux is about to appear. These pains are of the same kind with those which accompany abortions or births. Ought we not, therefore, to ascribe them to the same cause?

It appears, then, that the periodic revolution of the menstrual blood has great influence in child-bearing, and that it is the cause why the terms of delivery in women are more various than in other animals which are not subject to this discharge, and which always bring forth at the same times. It is also apparent, that the revolution occasioned by the action of the menstrual blood is not the only cause of birth: The action of the foetus itself contributes greatly to this end; for there are instances of children having made their escape from the uterus after the death of the mother, which could only happen from an exertion peculiar to the foetus.

The terms of gestation in cows, sheep, and other animals, are always the same, and no haemorrhage attends their delivery. May we not, therefore, conclude, that the blood discharged by women after delivery is the menstrual blood,

blood, and that the action of this blood upon the uterus, during every periodic revolution, is the reason why the human foetus is excluded at so many different terms? It is natural to imagine, that, if the females of viviparous animals had menses like women, their deliveries would be followed by an effusion of blood, and be equally various in their terms. The foetuses of animals are brought forth covered with their membranes; and it is seldom that the membranes are broken, or the waters flow before delivery. But the birth of a child, with its membranes entire, is a rare phaenomenon. This circumstance seems to evince, that human foetuses make greater efforts to escape from their prison than those of other animals, or that the uterus of a woman affords not so free a passage to the child; for it is by the struggles of the foetus against the resistance it meets with at the orifice of the uterus, that the membranes are torn.

R E C A P I -

RECAPITULATION.

ALL animals are nourished by vegetables, or by other animals which feed upon vegetables. There is, therefore, in Nature, a matter common to both, which serves for the growth and nourishment of every thing that lives or vegetates. This matter can have no other mode of effecting growth and nourishment, but by assimilating itself to every part of the animal or vegetable, and by intimately penetrating the texture and *form* of these parts, which I have distinguished by the appellation of an *internal mould*. When this nutritive matter abounds more than is sufficient for the growth and expansion of the animal or vegetable, it is detached from all parts of the body, and deposited in one or several reservoirs, under the form of a fluid. This fluid contains all the particles which are analogous to the different parts of the body, and, of course, all that is necessary for the reproduction of a being in miniature perfectly similar to the first. In most animals, this superfluity of nutritive matter does not take place till they have nearly acquired their full growth; and hence it is that animals are not capable of generating before this period.

When

When this nutritive and prolific matter, which is universally diffused, has passed through the internal mould of an animal or vegetable, and has found a proper matrix, it produces an animal or vegetable of the same species. But, when it finds not a suitable matrix, it produces organized beings different from animals or vegetables, as the moving and vegetating bodies which appear in the seminal fluids of animals, and in the infusions of the buds of plants, &c.

This prolific matter is composed of organic particles, which are always active, whose motions and actions are fixed or arrested by the brute parts of matter in general, and particularly by oily and saline substances; but, as soon as they are disengaged from this matter, which is foreign to their nature, they resume their action, and produce different species of plants, and other animated beings.

The effects of this prolific matter may be seen by the microscope in the seminal fluids of both male and female animals. The semen of viviparous females is filtrated through the glandulous bodies which grow upon their testicles; and these glandulous bodies contain a considerable quantity of seminal fluid in their cavities. Oviparous females, as well as the viviparous, have a seminal fluid, which is still more active than that of the viviparous. The semen of the female is, in general, similar to that of the male, when both are in a natural state. They decompose

pose in the same manner; they contain similar organic particles; and they exhibit the very same appearances.

All animal and vegetable substances contain a great quantity of this organic and prolific matter. To discover it, we have only to separate it from the brute matter in which it is entangled; and this operation is effected by infusing animal or vegetable substances in water: The salts melt; the oils separate; and the organic particles become evident by their movements. They abound more in the seminal fluid than in any other parts of animals; or rather, they are there more disengaged from the brute matter. Soon after flesh is infused, and while it is only slightly dissolved, the organic matter appears under the form of moving bodies, which are nearly as large as those in the seminal fluid. But, in proportion to the increase of the dissolution, the size of the organic particles is diminished, and their motion is augmented; and, when the flesh is entirely decomposed or corrupted, the organic particles are extremely minute, and their motion is inconceivably rapid. It is then that this matter may be poisonous, like that of the viper's tooth, in which Mr Mead perceived an infinite number of small pointed bodies, and which he imagined to be salts, though they are nothing but these same organic particles in an extremely active state. The pus which proceeds from wounds may acquire such a degree

of

of putrescence, as to become a poison of the most active kind; for, whenever this active matter is exalted to a certain point, which may always be distinguished by the rapidity and minuteness of the moving bodies it contains, it must become a species of poison. The same thing may be remarked with regard to the poison of vegetables. The same matter which nourishes us while in a natural state, will destroy us when it is corrupted, as appears from the gangrenes which affect the limbs of men and other animals, when they are fed with corrupted grain; and from comparing the residue of the food which adheres to our teeth, with that which proceeds from the teeth of the viper or of a mad dog, which is nothing but the same matter too much exalted, and in the highest state of putrefaction.

When large quantities of this organic and prolific matter are collected in some part of an animal, where it is obliged to remain, it there forms living beings, which we have always regarded as real animals. The taenia, the ascarides, all the worms found in the veins, in the liver, in wounds, in pus, and most of those which are formed in putrified flesh, have no other origin. The eels in paste, in vinegar, and all the pretended microscopic animals, are only different forms assumed, according to circumstances, by this active matter, which has a perpetual tendency to organization.

In infusions of all animal and vegetable substances, this prolific matter first discovers itself under the form of vegetation: We see it form into filaments, which grow and expand like plants; then their extremities and joints fwell and burst to give passage to the multitude of moving bodies which have the semblance of animals. Nature, it would appear, begins all her operations by a kind of vegetable motion: This motion we perceive in a variety of microscopic objects, and in the expansion of the animal embryo; for a foetus, at first, possesses only a species of vegetable growth or motion.

Sound food furnishes none of these moving particles for a considerable time: Fresh meat, grain, fruits, &c. require some days infusion before they exhibit any moving bodies. But the more any matter is corrupted, decomposed, or exalted, as pus, blighted grain, honey, the seminal fluids, &c. these moving bodies make their appearance the sooner. In seminal fluids, they are entirely free from other matter; and only a few hours infusion are necessary to discover them in pus, corrupted grain, honey, strong drugs, &c.

The existence, therefore, of an organic animated matter, universally diffused through all animal and vegetable substances, and which equally serves for their nourishment, their growth, and their reproduction, is apparent. Nutrition is effected by the intimate penetration of this matter

matter through every part of animal or vegetable bodies ; expansion, or growth, is only a more extensive species of nutrition, which proceeds as long as the parts are ductile, and capable of being stretched ; and reproduction is an effect of the same matter, when it superabounds in the body of an animal or vegetable. Every part of organized bodies sends off to proper reservoirs the organic particles which are superfluous for its nourishment : These particles are perfectly similar to the different parts from which they are detached, because they were destined for the nourishment of those parts. Hence, when the whole particles sent off from every part of the body are assembled, they must necessarily form a small body similar to the original, because every particle is similar to the part from which it was detached. It is in this manner that every species of reproduction, where only one individual is requisite, as that of trees, plants, polypi, vine-fretters, &c. is effected. This is also the first method employed by nature for the reproduction of such animals as require the aid of different sexes ; for the seminal fluid of each sex contains all the particles necessary for reproduction : But, to complete the operation, something more is requisite, namely, the mixture of both fluids in a place suited to the expansion and growth of the foetus ; and this place is the uterus of the female.

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There are, therefore, no pre-existing germs, or germs infinitely contained within each other. But there is an organic matter diffused through all animated nature, which is always active, always tending to form, to assimilate, and to produce beings similar to those which receive it. The species of animals and of vegetables, therefore, can never be exhausted: As long as individuals subsist, the different species will be constantly new; they are the same now that they were three thousand years ago: The whole will perpetually exist by their own powers, unless they be annihilated by the will of their Creator.

THE

T H E

N A T U R A L H I S T O R Y

O F

M A N:

S E C T. I.

Of the Nature of Man.

THOUGH man be much interested in obtaining a knowledge of himself, yet I suspect that he is better acquainted with every other object. Endowed by Nature with organs destined solely for our own preservation, we employ them for the reception of external impressions only. Anxious to expand our external existence beyond the limits of our powers, and to multiply the functions of our senses, we seldom employ that internal sense which reduces us to our true dimensions, and distinguishes us from every other being. If, however, we are

desirous of knowing ourselves, we must cultivate this sense, by which alone we are enabled to form a dispassionate judgment concerning our nature and condition. But how shall we give to this sense its full extent and activity? How shall we emancipate the soul, in which it resides, from all the illusions of fancy! We have lost the habit of employing this sense; its activity is repressed by the tumult of corporeal sensations, and parched with the heat of our passions; the heart, the imagination, the senses, all conspire to annihilate its exertions. Unchangeable, however, in its nature, and invulnerable by its essence, it continues always the same. Its splendour may be obscured, without losing its force; it may enlighten us less, but it guides us with certainty. Let us collect those rays which it still emits, and the darkness which surrounds us will diminish; and, though the path should not be equally illuminated from one end to the other, we shall at least have a torch to prevent us from wandering.

The first and most difficult step, in arriving at a proper knowledge of ourselves, is to acquire distinct ideas of the two substances of which we are composed. Simply to affirm, that the one is immaterial, unextended, and immortal, and that the other is material, extended, and mortal, is only denying those qualities to the one, which we know the other possesses. What real knowledge can be acquired from this mode of negation?

negation? Such negative expressions can communicate no positive idea. But, to say that we are certain of the existence of the former, and less assured of that of the latter; that the substance of the one is simple, indivisible, and has no form, because it manifests itself only by a single modification, which is that of thought; that the other is less a substance, than a subject capable of receiving species of forms relative to our senses, which are all as uncertain and as variable as the organs themselves, is advancing one step towards a distinct idea of the nature of the two substances: it is ascribing to both different and peculiar properties; it assigns to them positive qualities, and enables us to institute a comparison between them.

All our knowledge is ultimately derived from comparison. What is absolutely incomparable, must be incomprehensible. Of this God is the only example: He cannot be comprehended, because he can be compared with no other being. But every thing which is susceptible of being compared, and of being relatively viewed in different lights, becomes a source of human knowledge. The more subjects of comparison which any object affords, the means of forming a proper knowledge concerning it are proportionally increased and facilitated.

The existence of the soul is self-evident: To be, and to think, are, with regard to us, the same thing. This truth is more than intuitive: It is

independent of the senses, of the imagination, of the memory, and of all our other relative faculties. But the existence of our bodies, and of external objects, is doubtful to every unprejudiced reasoner ; for that extension in length, breadth, and thicknes, which we call our bodies, and which seem to be so intimately connected with us, is nothing more than a relation of our senses ; and the organs of sensation themselves are only certain affinities with the objects which affect them. Has the internal sense, the mind, any thing common or similar to these organs ? Have the sensations produced by light or sound any resemblance to that subtile fluid which excites the idea of light, or to the vibration of the air which conveys to us the notion of sound ? These effects result solely from the necessary and intimate relation that subsists between the eyes and ears and the different matters which act upon them. But, as we have demonstrated, that there is no resemblance between sensations and the objects which produce them, is not this a sufficient proof that the nature of the soul is different from that of matter ?

We may, therefore, consider it as an established point, that internal sensation is totally different from its cause ; and we have already shown, that, if external objects exist, they must be very different from the ideas we form of them ; because sensation has not the most distant resemblance to the objects by which it is excited.

May

May we not hence conclude, that the causes of our sensations necessarily differ from our notions concerning them? That extension which we perceive by the eye, that impenetrability of which we acquire the idea by touching, and all the other constituent properties of matter, may have no existence; since our internal sensations of extension, impenetrability, &c. are neither extended nor impenetrable, and possess nothing in common with these qualities.

As the mind, during sleep, is affected with sensations which are often different from those excited by the actual presence of the objects, is it not natural to think, that the presence of objects is not necessary to the existence of our sensations, and, consequently, that both mind and body may exist independent of these objects? For, during sleep and after death, the body has the same existence as before, though the mind recognises not this existence, and, with regard to us, the body entirely loses its being. Now I ask, if any object that can exist, and afterwards be no more, which affects us in a manner totally different from what it is, and from what it has been, can be so real as to leave no doubt of its existence?

We may still, however, believe, though we are uncertain, that something exists without us; but we cannot hesitate concerning the real existence of every thing within us. The existence of the soul, therefore, is certain, and that of the

body seems to be doubtful. The mind has one mode of perception when we sleep, and another when we are awake; after death, she will perceive in a manner still more different; and the objects of sensation, or matter in general, may then have no more existence with regard to her, than our bodies, with which we have no farther connection.

But, though we admit the existence of matter, and that it exists in the very manner we perceive it; yet, in comparing it with the mind, we shall find the latter endowed with qualities so opposite, that we cannot hesitate concerning the difference of its nature, and the superiority of its rank.

It is impossible to recognise the mind under any other form than that of thinking, which is extremely general, simple, and uniform. This form is not divisible, extended, impenetrable, nor possesses any other quality of matter. The mind, therefore, which is the subject of this form, must be indivisible and immaterial. Our bodies, on the contrary, as well as all external objects, have many forms, each of which is compounded, divisible, and destructible; and the whole are only relative to the different organs by which we perceive them. Our bodies, and matter in general, therefore, possess no constant, real, or universal properties, which can enable us to acquire a certainty of their existence. A blind man has no idea of the images of bodies presented

presented to us by means of light. A leper, whose skin was insensible, could have none of those ideas which originate from the sense of feeling. A deaf man knows nothing of sound. Supposing a person to be successively deprived of these three instruments of sensation, the mind would still exist, and manifest itself by its own internal power of thinking. But, if you abstract colour, extension, solidity, and all the other qualities of matter which have a relation to our senses, matter, in this case, would be entirely annihilated : The mind, therefore, is indestructible ; but matter may, and must perish.

The same reasoning applies to the other faculties of the mind, when compared with the most essential properties of matter. The mind wills and commands ; the body obeys as far as it is able : The mind can unite itself, in an instant, to the most distant or most elevated objects ; and nothing can prevent this union, when the commands it to be effected. But the body is incapable of uniting with any object ; it is wounded by every thing that makes too close an approach. Every thing resists and becomes an obstacle to its motions, which are naturally slow. Is this will, then, nothing more than a corporeal movement ; and is contemplation only a simple contact ? How could this contact be effected with remote objects, or abstract subjects ? Or how could this motion be instantaneously accomplished ? Without space and time,

the

the idea of motion is inconceivable. The will, therefore, if it be a motion, is not a material motion ; and, if the union of the mind with its object be a contact, it must be a contact, or rather an intimate penetration, at a distance ! qualities which are the reverse of those of matter, and which, of course, can belong only to an immaterial being.

But I am apprehensive of having dwelt too long upon a subject, which, by some, may be regarded as foreign to the nature of this work. What connection, it may be said, have metaphysical remarks on the mind with natural history ? If I were conscious of abilities sufficient for the discussion of a topic so elevated and extensive, this reflection, I acknowledge, would not give me any uneasiness ; and I have abridged my observations, solely because I despaired of being able to comprehend a subject so immense, and so important in its nature. Why should the noblest part of man be rejected from his history ? Why thus preposterously debase him, by considering him merely as an animal, while his nature is so different, and so superior to that of the brutes, that nothing but the most brutal ignorance could ever dream of confounding them ?

Man, it is true, resembles the other animals in the material part of his being ; and, in the enumeration of natural existences, we are obliged to rank him in the class of animals. But, in nature, there are neither classes nor genera ; all

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are mere independent individuals. Classes and genera are only the arbitrary operations of our own fancy: And, though we place man in one of these classes, we change not his nature; we derogate not from his dignity; we alter not his real condition; we only assign him the first rank among beings which resemble him solely in the material part of his existence.

When we compare man with the animal creation, we find in both a material organized body, senses, flesh and blood, motion, and many other striking resemblances. But all these analogies are external, and authorise us not to pronounce, that the nature of man is similar to that of the brute. In order to acquire a distinct idea concerning the nature of each, it is necessary that we should have as complete a knowledge of the internal qualities of animals as we have of our own. But, as it is impossible to know what passes within animals, or how to rank or estimate their sensations, in relation to those of man, we can only judge by comparing the effects which result from the natural operations of both.

Let us, therefore, consider these effects; and, while we acknowledge all the particular resemblances, we shall only examine some of the most general distinctions. The most stupid man, it will be admitted, is able to manage the most alert and sagacious animal: He governs it, and makes it subservient to his purposes. This he

effects

effects not so much by strength or address, as by the superiority of his nature. He compells the animal to obey him, by his being possessed of reason, which enables him to project and to act in a systematic manner. The strongest and most sagacious animals have not the capacity of commanding the inferior tribes, or of reducing them to a state of servitude. The stronger, indeed, devour the weaker: But this action implies an urgent necessity only, and a voracious appetite, qualities very different from that which produces a train of actions all directed to one common design. If animals be endowed with this faculty, why do not some of them assume the reins of government over others, and force them to furnish their food, to watch over them, and to relieve them when sick or wounded? But, among animals, there is no mark of subordination, nor the least trace of any of them being able to recognize or feel a superiority in his nature above that of other species. We should, therefore, conclude, that all animals are of the same nature, and that the nature of man is not only far superior, but likewise of a very different kind from that of the brute.

Man exhibits, by external signs, what passes within him. He communicates his sentiments by words; and this sign is universal. The savage and the civilized man have the same powers of utterance; both speak naturally, and are equally understood. It is not owing, as some have

have imagined, to a defect in their organs, that animals are denied the faculty of speech. The tongue of a monkey has been discovered by anatomists to be as perfect as that of a man*. The monkey, therefore, would speak, if it could think. If the train of its thoughts were analogous to that of ours, it would speak the language of men; and supposing the order and manner of its thinking to be peculiar to the species, it would still speak a language intelligible to its neighbours. But apes have never been discovered conversing together. Instead, therefore, of thinking in a manner analogous to man, they seem not to have the smallest order or train in their thoughts. As they express nothing that exhibits combination or arrangement, it follows, either that they do not think, or that the limits of their thinking are extremely narrow.

As several species of animals are capable of being taught to pronounce words, and even to repeat sentences, this is an invincible proof that the want of speech among them is not owing to any defect in their organs. Many other brutes might, perhaps, be taught to articulate words †; but, to make them conceive the ideas which these words express, is beyond the power of art. They seem to articulate and to repeat merely like an echo or a machine. They are defective,

* See M. Perault, History of Animals.

† Leibnitz mentions a dog that had been taught to pronounce several French and German words.

defective, not in the mechanism of their organs, but in their intellectual powers.

Language implies a train of thinking; and it is for this reason that brute animals are incapable of speech: For, though we should allow them to possess something similar to our first apprehensions, and to our most gross and mechanical sensations, it is certain that they are unable to form that association of ideas in which alone the essence of reflection and of thought consists. They can neither think nor speak, because they can neither join nor separate ideas; and, for the same reason, they neither invent nor bring any thing to perfection. If they were endowed with the power of reflecting, even in the slightest degree, they would be capable of making some progress, and acquire more industry; the present race of beavers would build their houses with more art and solidity than their progenitors; and the bee would daily improve the cell which she inhabits: For, by supposing that this cell has all the perfection of which it is capable, we ascribe to this insect a genius and understanding superior to the human, by which it is enabled, at one glance, to perceive the utmost point of perfection to which its work can be carried. But man never can attain a clear view of this point: Much time, reflection, and practice, are necessary, before the meanest of our arts can be brought to maturity.

Whence

Whence proceeds this uniformity in all the operations of animals? Why does every species perform the same work in the very same manner? And why is the execution of different individuals neither better nor worse than that of every other? Can there be a stronger proof that their operations are only the results of pure mechanical impulse? If they possessed a single spark of that inward light which illuminates mankind, we should find variety, at least, if not perfection, in their works; every individual would exhibit some difference in his mode of execution. But such differences never appear: They all work upon the same plan; their mode of acting runs through the whole species, and is not peculiar to any individual: If, therefore, we ascribe to animals a mind or soul, we must allow but one to every species, of which each individual has an equal share: This soul would, of course, be divisible, and, consequently, material, and very different from ours.

Why, on the contrary, is so much variety exhibited in the operations of men? Why does servile imitation cost us more labour than original design? Because our souls are proper to us, and independent of any other; and because we possess nothing common to the species, but the matter which constitutes our bodies, and by which alone we have any resemblance to the brute creation.

If

If internal sensation depended on corporeal organs, should not as great a variety appear in the operations of the same species of animals, as in those of men? Would not those endowed with finer organs build their nests, and their cells, in a manner more solid, elegant, and commodious? If any individual had more genius than another, would it not be rendered conspicuous by its mode of acting? But nothing of this kind is ever exhibited: The greater or lesser perfection of corporeal organs, therefore, has no influence upon the nature of internal sensation. From this circumstance, we may safely conclude, that animals possess no sensations of this kind; that they neither belong to matter, nor depend, as to their nature, upon the texture of corporeal organs; and of course that there is in man a substance totally distinct from matter, which is the subject and the cause that produce these sensations.

But these proofs of the immateriality of the human mind may be extended still farther. We have often remarked, that Nature proceeds in her operations by imperceptible degrees. This truth, which otherwise admits of no exception, is here totally reversed. Between the faculties of man and those of the most minute animal, the distance is infinite. This is a clear proof, that the nature of man is different from that of the brute creation; that he himself constitutes a separate class from which there are numberless degrees

degrees of descent, before we arrive at the state of the mere animal; for, if man were of the same rank with the animals, there would be in nature a certain number of beings less perfect than man, and superior to any animal we are acquainted with; and those intermediate beings would descend imperceptibly from man to the monkey tribes. But no such beings exist. The passage is sudden from a thinking being to a material one, from intellectual faculties to mechanical powers, from order and design to blind impulse, from reflection and choice to ungovernable appetite.

This is a strong indication of the excellence of our nature, and of the immense distance fixed by the bounty of the Creator between men and animals. Man is a reasoning being; the animal is totally deprived of that noble faculty: And as there is no intermediate point between a positive and a negative, between a rational and an irrational animal, it is evident that man's nature is entirely different from that of the animal; that the latter only resembles the former in the external or material part; and that, to form a judgment from this material resemblance alone, is shutting our eyes voluntarily against that light which enables us to distinguish truth from falsehood.

Having considered the internal nature of man, and demonstrated the immateriality of his soul, we shall next examine his external part, and give

give the history of his body. In the preceding chapters, we have explained his formation and expansion, and traced him to the very moment of his birth: Let us now run over the different ages of his life; and, after conducting him to that period when he is separated from his body, we shall leave it to moulder in the common mass of matter to which it originally belonged.

S E C T.

Of Infancy.

NOTHING exhibits such a striking picture of weakness, of pain, and of misery, as the condition of an infant immediately after birth. Incapable of employing its organs or its senses, the infant requires every kind of succour and assistance: It is more helpless than the young of any other animal: Its uncertain life seems every moment to vibrate on the borders of death. It can neither move nor support its body: It has hardly force enough to exist, and to announce, by groans, the pain which it suffers; as if Nature intended to apprise the little innocent, that it is born to misery, and that it is to be ranked among human creatures only to partake of their infirmities and of their afflictions.

Let us not disdain to consider that state in which our existence commenced: Let us view human nature in the cradle; and, leaving the disgust that might arise from a detail of the cares which infancy demands, let us inquire by what degrees this delicate and hardly existing machine acquires motion, consistency, and strength.

An infant, at birth, passes from one element into another. When it escapes from the waters which surrounded it in the womb of the mother, it is exposed to the air, and instantly feels the impressions of that active fluid. The air acts upon the olfactory nerves, and upon the organs of respiration. This action produces a shock, a kind of sneezing, which expands the chest, and gives the air a free passage into the lungs, the vesicles of which it dilates. After the air remains for some time, it is heated and rarified to a certain degree, and the stimulus or spring arising from the dilatation of the fibres re-acts upon this rarified fluid, and expells it from the lungs. We will not here attempt to explain the causes of the alternate motion of respiration, but shall confine ourselves to its effects.

This function is essentially necessary to the existence of man and of many other animals. If respiration ceases, the animal must perish; when once commenced, it never stops till death; and, after the foetus begins to respire, it continues this action without interruption. It is probable, however, that the foramen ovale of the heart does not close immediately after birth, and, consequently, that part of the blood must pass through that aperture. The whole blood, therefore, enters not, at first, into the lungs; and a new-born child may perhaps be deprived of air for a considerable time without suffocation. This conjecture

jecture seems to be confirmed by some experiments I lately made upon young dogs. I procured a pregnant bitch, of the large gray-hound kind, and, when just about to litter, I fixed her so in a bucket full of warm water, that her hinder parts were entirely covered. In this situation she brought forth three puppies, which, after being disengaged from their membranes, were immersed in a fluid nearly of an equal temperature with that of the amnios. After assisting the mother, and washing the puppies in this water, I suddenly removed them into a pail of warm milk, without allowing them time to respire. I put them into the milk, in preference to water, that they might have an opportunity of taking some food, if they found a desire for nourishment. I kept them immersed in the milk for more than half an hour; and, when taken out of it, all the three were alive. They began to breathe; and they discharged a quantity of fluid matter by the mouth. I allowed them to respire about half an hour, and again immersed them in the warm milk, where they remained another half hour. I then took them out: Two of them were still vigorous; but the third seemed to languish: I therefore ordered it to be carried to the mother, which, beside the three brought forth in the water, had littered other six in the natural manner. The puppy which was born in the water, and had continued one half hour in warm milk, before it was allowed

to breathe, and another half hour after it had respired, seemed to be very little incommoded ; for it soon recovered, and was as active and lively as those which had received no injury. Of the six that were brought forth in the air, I threw away four ; so that there remained only two with the mother, beside the one that had been littered in the water. I continued my experiments upon the other two which had been twice immersed in the milk : After allowing them to breathe about half an hour, I plunged them a third time into the milk, where they remained another half hour. Whether they swallowed any of the milk, I could not determine ; but, when removed, they appeared to be nearly as vigorous as before their immersion. Having carried them, to the mother, however, one of them died that same day ; but I know not whether its death was owing to some accident, or to the injury it received from being plunged into the milk, and deprived of air. The other lived as well as the first ; and both grew up, and were equally vigorous as those which had not been subjected to the experiment. I pushed these trials no farther : But I learned enough to convince me, that respiration is not so indispensably necessary to the existence of a new-born animal, as to an adult ; and that, by employing certain precautions, it is, perhaps, possible to keep the foramen ovale open, and, by this means, produce excellent divers, or a species of amphibious animals,

which

which would be able to live equally in air or in water.

The air, on its first entrance into the lungs, generally meets with some obstacle, occasioned by a fluid substance collected in the wind-pipe. This obstacle is greater or less, in proportion to the viscidness of the liquor. But the infant, at birth, raises its head, which formerly reclined on its breast; and, by this operation, the canal of the wind-pipe is lengthened; the air, of course, rushes in, forces this fluid into the cells of the lungs, which it dilates; and, in this manner, the mucous substance, which opposed the free passage of the air, is diffused through the whole substance of the lungs. The perpetual admission of fresh air soon dries up this superfluous moisture; or, if it should still incommod the infant, it excites a cough, and is thrown off by expectoration, which generally runs out of the mouth, because the child has not yet strength enough to spit.

We can remember nothing that passes at this early period of our existence. It is, therefore, impossible to discover the feelings produced in the child by the first impressions of the air. But the cries and groans it utters immediately after birth, are certain indications of the pain occasioned by the action of the atmosphere. Till the moment of birth, the infant is accustomed to the mild warmth of a tranquil fluid. It is, therefore, consonant to reason, that the action of a fluid,

unequal in its temperature, is too violent for the lax and delicate fibres of a new-born infant. It is equally sensible of heat as of cold : In every situation it utters complaints ; and pain appears to be its first and only sensation.

Most animals are blind for some days after birth. Infants open their eyes the moment they come into the world ; but their eyes are fixed and dull : They have not that lustre and brilliancy they afterwards acquire ; neither have they those motions which accompany distinct vision. But they seem to feel the impression of light ; for the pupil contracts or dilates, in proportion to the quantity of light. A new-born infant cannot distinguish objects ; because the organs of vision are still imperfect : The cornea is wrinkled ; and perhaps the retina is too soft and lax for receiving the impressions of external bodies, and for producing the sensations peculiar to distinct vision.

The same remark may be applied to the other senses. They have not yet acquired that force and consistency which the operation of the senses demand : And, even when they arrive at this state, it is long before the sensations of the infant can be just and complete. The senses are instruments of which we must gradually learn the use. That of vision is the most noble, and the most wonderful ; but, at the same time, it is the most uncertain and clusory. The sensations produced by it, if not rectified every moment

ment by the sense of touching, would uniformly lead us into false conclusions. The sense of touching is the criterion of all the other senses: It alone is essential to animal existence, and is universally diffused through every part of the body. But even this sense is imperfect at birth: A new-born infant, indeed, discovers symptoms of pain by its cries and its groans; but it has no expression that indicates pleasure. It begins not to smile in less than 40 days: It is about this time, likewise, that it begins to weep; for its former cries were not accompanied with tears. There are no vestiges of the passions in the countenance of a new-born child. The features of the face have not acquired that consistence and elasticity which are necessary for expressing the sentiments of the mind. All the other parts of the infant's body are extremely feeble; and their motions are awkward and ill-directed. It is unable to stand erect; its thighs and legs are still bended, from the habit contracted while in the womb of the mother; it has not strength to stretch out its arms, or to lay hold of any thing with its hands; and, if abandoned in this condition, it would remain on its back, without being able to turn to one side or another.

From these remarks, it appears, that the pain felt by infants recently born, and which they express by crying, is only a corporeal sensation, similar to that of other animals, who likewise cry the moment they are brought forth; and

that

that mental sensation commences not sooner than 40 days after birth; for smiles and tears are the effects of two internal sensations, which both depend upon the action of the mind. The former is an agreeable sensation, which originates from the sight or remembrance of a known and desirable object: The latter is a disagreeable agitation, compounded of sympathy and anxiety concerning our own welfare. Both these passions presuppose a certain degree of knowledge, and a power of reflecting, and of comparing ideas. Smiles and tears are expressions of pleasure and pain peculiar to the human species; for the cries, the motions, and the other marks of bodily pains and pleasures, are common to man and most of the other animals.

But we must now return to the material organs and affections of the body. The size of an infant born at the full time is generally about 21 inches, though some exceed, and others fall much below this standard. The breast of a child of 21 inches, measured by the length of the sternum, is about three inches, and only two, when the infant exceeds not 14 inches in length. At nine months, a foetus generally weighs from 12 to 14 pounds. The head is large in proportion to the body; but this disproportion gradually wears off, as the infant increases in size. The skin of a new-born child is very fine, and of a reddish colour, its trans-

parency

parency allowing a slight tint of the blood to shine through. It is even alledged, that the redder the skin of an infant is at birth, it will afterwards become the fairer and more beautiful.

The form of the body and members of infants, recently after birth, is by no means perfect. The parts are too much rounded ; and, even when the child is in high health, they have a swollen appearance. A kind of jaundice generally comes on at the end of three days ; and, at the same time, there is milk in the breasts of infants, which is squeezed out by the fingers. As the growth of the child increases, the superfluous juices and swelling of the parts gradually diminish.

In some infants, a palpitation may be seen in the fontanella, or open of the head ; and, in every child, the beating of the sinuses, or arteries of the brain, may be felt at this place. Above this opening, a species of scurf appears, which is often very thick, and must be rubbed off with a brush, when it becomes dry. This matter seems to have some analogy to the horns of quadrupeds, which likewise derive their origin from an opening in the skull, and from the substance of the brain. We shall afterwards show, that the extremities of the nerves become solid when exposed to the air ; and that horns, nails, claws, &c. are genuine productions of this nervous substance.

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The fluid contained in the amnios leaves upon the infant's body a viscid whitish matter, which is sometimes so adhesive, that it requires to be diluted with some mild liquid before it can be removed. In this country, we always wash the infant with warm liquors ; but there are whole nations, who inhabit climates much colder than ours, where the infants are plunged into cold water as soon as they are born, without receiving the smallest injury. The Laplanders are even said to leave their new-born infants in the snow till their respiration is almost stopped with cold, and then throw them into a warm bath. This rough treatment is continued three times every day for the first year : And, after that period, the children are bathed thrice a week in cold water. The inhabitants of the northern regions are firmly persuaded that cold bathing makes men more healthy and robust ; and, therefore, they inure their children to this habit from their very birth. We are, indeed, totally ignorant how far our bodies may be rendered capable of suffering, of acquiring, or of losing, by the power of habit. The savages in the isthmus of America, when covered with sweat, plunge themselves into cold water with impunity : The women throw their drunk husbands into the rivers, in order the more speedily to remove the effects of intoxication : The mothers bathe in cold water along with their infants the moment after they are delivered ; and yet

yet much fewer of them die of child-bearing than in other countries, where a practice of this kind would be regarded as extremely dangerous.

Infants, a few minutes after birth, and generally after feeling the heat of a fire, discharge urine, and likewise the meconium- or excrement which had been formed in the intestines during their abode in the womb. But this last evacuation does not always happen so soon ; and, when it is retarded during the first day, the child is often affected with cholic pains ; the discharge must, therefore, be promoted by proper remedies. The meconium is black, and, when entirely purged off, the stools are of a whitish colour. This change generally happens on the second or third day. The odour of the excrement becomes then more offensive than that of the meconium ; which is a proof that the bile, and other bitter humours of the body, begin to be mixed with the faeces.

This observation seems to confirm what was formerly advanced concerning the growth and nourishment of the foetus. We then remarked, that the foetus was nourished by absorption, and that it received no food by the mouth. This change in the odour of the excrement is a proof that the stomach and intestines of the foetus have no action, or, at least, that they act not in the same manner, as after the motions communicated to them by respiration ; since it is only after this period that digestion, and the mixture of

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the bile and pancreatic juice with the food, takes place in the stomach and intestines. Thus, though the bile and pancreatic juice are secreted in the foetus, these liquors remain in their reservoirs, and pass not into the intestines ; because, like the stomach, these reservoirs have yet no motion or action sufficient to make them empty their contents into the receptacles of the food.

Before the child is allowed to suck, we allow it time to discharge the slime and meconium in its stomach and bowels. As these substances might sour the milk, and produce bad effects, we first give the child a little wine and sugar, in order to fortify its stomach, and to promote such evacuations as are necessary to prepare it for receiving and digesting its food. Ten or twelve hours, therefore, ought to elapse, before the child be allowed to suck for the first time.

The infant has hardly escaped from the womb of its mother, and enjoyed the liberty of stretching its limbs, when it is again condemned to a more cruel and unnatural bondage. The head of the little innocent is fixed ; its legs are fettered ; its arms are bound down to its sides ; and it is laced with bandages so strait, that it cannot move a single joint. It is a fortunate circumstance, when the swaddlings are not drawn so tight as to stop respiration, or when the midwife has the sense to lay the miserable captive on its side, that the natural moisture may spontaneously flow from its mouth ; for it is denied

denied the liberty of turning its head to facilitate this necessary discharge. Is it not an instance of superior wisdom in those nations, who simply clothe their infants, without tormenting them with swaddling-bands? The Siamese, the Indians, the Japanese, the Negroes, the savages of Canada, of Virginia, of Brasil, and almost all the inhabitants of South America, lay their infants naked into hanging beds of cotton, or put them into cradles lined with fur. These practices are both sensible and humane: The restraint of swaddling-bands must be painful. The efforts made by infants to disentangle themselves have a more direct tendency to distort their members, than any positions they could assume, if left in the full possession of liberty. Swaddling-bands may be compared to the stays worn by young girls, which occasion many more deformities and diseases than they are intended to prevent.

If the efforts for liberty made by infants thus fettered be hurtful, the inactivity to which they are condemned is, perhaps, still more noxious. The want of exercise retards the growth of their members, and diminishes the strength of their bodies; and, of course, those children who are allowed full freedom of motion will be the most vigorous and healthy. It was this motive that induced the Peruvians to leave the arms of their infants perfectly loose, in a wide swathing-bag: Afterwards, when their children grew older,

they

they put them up to the middle in a hole dug out of the earth, and lined with linen ; their arms, by this contrivance, were at full liberty ; and they could move their heads, and bend their bodies, without falling, or hurting themselves. As soon as they were able to step, the breast was presented to them at a little distance, to entice them to walk. The children of Negroes are often exposed to greater difficulties before they can approach the nipple ; they cling round one of the mother's haunches with their knees and legs ; they adhere so fast, that they support themselves without the assistance of the mother ; they lay hold of the breast with their hands ; and they continue to suck without inconvenience or danger of falling, though the mother moves about or works at her ordinary labour. These children begin to walk or rather to creep, on their hands and knees, at the end of the second month ; and, by exercise, they acquire the faculty of running, in this situation, with nearly equal quickness as they do upon their feet.

Infants, recently after birth, sleep much ; but their sleep is often interrupted. As they likewise require frequent nourishment, they ought to have the breast once every two hours during the day, and, in the night, as often as they awake. At first, they sleep almost continually ; and they seem never to awake but when stimulated by hunger or pain : Their sleep, therefore, generally terminates by a fit of crying. As, in the cradle,

cradle, they are obliged to lie in the same position, and are chained down by bandages, this situation soon becomes painful. They are besides often wet and chilled by their excrements, the acrimony of which irritates their delicate and sensible skin. In this condition, the efforts of children are extremely feeble; and their calls for relief are expressed by cries and groans. This succour should always be speedily administered; or rather the inconveniences they feel should be prevented, by frequently changing part of their clothing. The savages are so attentive to this article, that, though they cannot change their furs so often as we do our linen-cloths; yet they supply this defect by employing other substances, of which they have no occasion to be sparing. In North America, they put wood dust, which they obtain from trees that have been corroded by worms, into the bottom of the cradle, and renew it as often as necessary: The children are laid upon this powder, and covered with skins. Though this powder may, perhaps, be as soft as our down-beds; yet they use it not for the purposes of delicacy, but because it quickly absorbs moisture of every kind. In Virginia, they place the child naked upon a board covered with cotton, and provided with a hole for the passage of the excrement. The cold in this country is unfavourable to such a practice; but it is almost general in the east of Europe, and particularly in Turkey. This pre-
caution

caution has another advantage; it precludes all kind of care, and prevents the dreadful effects which too commonly result from the common negligence of nurses. Nothing inferior to maternal affection can support that perpetual vigilance and minute attention which the infantine state requires. With what propriety, then, can such exertions be expected from ignorant and mercenary nurses?

Some nurses desert their children for several hours without feeling the smallest anxiety: Others are so callous as not to be affected with their cries. In this situation the unfortunate infants seem to despair; they exert all the force of which they are capable; and their cries only cease when their strength is exhausted. This excessive crying either occasions diseases, or at least throws them into a state of lassitude, which deranges their constitutions, and may have some influence on their tempers. Indolent nurses are guilty of another abuse: Instead of employing proper means for pleasing the child, they rock it violently in the cradle. This agitation confuses the brain, stops the crying, and, if long continued, stuns the child into sleep. But this forced and unnatural sleep is only a palliative; it removes not the original cause of complaint. Long and violent rocking, on the contrary, may disorder the stomach and head, and lay the foundation of future disorders.

Before

Before children are put into the cradle we ought to be certain that they want nothing; and they should never be rocked with such violence as to confound or stun them. If they sleep not sufficiently, a gentle and equal motion may be employed. Neither should they be often rocked; for, if they be once accustomed to this motion, they will not afterwards sleep without it. Though children, when in health, should sleep long without the assistance of art; yet their constitution may be injured by too much sleep. In this case, they should be roused by gentle motion, by soft and agreeable sounds, and by amusing them with brilliant objects. This is the period when they receive the first impressions from the senses, which are, perhaps of more importance during life than is generally imagined.

Infants always direct their eyes to the lightest part of a room; and if, from the child's situation, one eye only can see the most luminous part, the other, for want of equal exercise, will not acquire equal strength. To prevent this inconvenience, the foot of the cradle, whether the light proceeds from a window or a candle, should be placed opposite to the light: In this position both eyes receive the light at the same time, and consequently acquire, by exercise, an equal degree of strength: If one eye acquires more strength than the other, the child will squint; for I have elsewhere proved, that an inequality of strength in the eyes is the cause of squinting *.

For the first two months, the infant should receive no other food than the milk of the mother or nurse; and, if its constitution be delicate, this nourishment alone should be continued during the third and fourth month. A child, however robust, may be injured, if any other food be administered before the end of the first month. In Holland, in Italy, in Turkey, and through the whole Levant, children are allowed no other food during the first year. The savages of Canada nurse their children four or five, and sometimes six or seven years. In our country, as most nurses have not a sufficient quantity of milk to satisfy the desires of their children, in order to spare it, they give them, even from the beginning, a composition of boiled bread and milk. This nourishment appeases hunger; but, as the stomach and intestines are yet too weak to digest such a gross, viscid substance, the children are greatly hurt by it, and often die of indigestion.

The milk of animals, in cases of necessity, may supply that of the mother: But then the child should be obliged to suck the animal's teat, that it may receive the milk in an equal and proper degree of heat, and that, by the action of the muscles in sucking, the milk may be mixed with saliva, which greatly promotes digestion. I have known several peasants who had no other nurses than ewes; and yet they were equally vigorous

vigorous as those who had been nursed by their mothers.

After two or three months, when the child has acquired some strength, it may have food somewhat more solid, as flour baked with milk, a species of bread which gradually disposes the stomach to receive common bread, and such other nourishment as it must afterwards be accustomed to take.

The consistence of liquid food is thus gradually increased, that the child's stomach may be prepared to receive what is still more solid. Infants, during the first year, are incapable of mastication. The rudiments of the teeth are still covered with the gums, which are so soft, that they can have little effect upon hard substances. Some nurses, especially among the common people, first chew the food, and then give it to their children. Before reflecting on this practice, we must throw aside every idea of disgust, of which children, at this age, have not the least conception. They are equally disposed to receive nourishment from the mouth of the nurse, as from her breasts. This custom seems to have originated from some natural instinct; for we meet with it in many countries which are exceedingly remote from each other; as in Italy, in Turkey, in most parts of Asia, in America, in the Antilles, in Canada, &c. As it is the only way by which the stomachs of children can be supplied with a proper quantity of saliva, I believe it is very use-

ful to them. If the nurse chews a bit of bread, it is soaked in her saliva, which renders it fitter for nourishment than if it had been diluted in any other liquor. This practice, however, is unnecessary after children are furnished with teeth, which enable them to chew their food, and to mix it with their own saliva.

The *incisores*, or cutting teeth, are eight in number, four in each jaw, and they generally appear about the seventh month, though, in some cases, not till the end of the first year. These teeth are often premature; for some children have them at birth, and foetuses have been found with teeth completely formed long before the ordinary time of gestation is finished.

The rudiments of the teeth are lodged in sockets, and covered with the gums: In the process of their growth, they extend their roots to the bottom of the socket, and break through the gums. This process observes not the ordinary laws of Nature, which act continually on the human body, without occasioning any painful sensation. Here Nature makes a violent and painful effort, which is often attended with fatal consequences. Children, when teething, lose their usual sprightliness; and become peevish and fretful. The gums are at first red and swelled; and, when the circulation of the blood is nearly stopped by the pressure of the teeth, they turn whitish. Children perpetually apply their fingers to the affected part, in order to remove

move the irritation: To procure still farther relief, they are furnished with a piece of ivory, coral, or any other hard smooth substance, which they rub against the gums. This operation relaxes the parts, affords a momentary cessation of pain, renders the gums thinner, and facilitates their rupture. But, notwithstanding every precaution, the rupture of the gums is always accompanied with pain and danger. When the gums are uncommonly strong and rigid, they resist the pressure of the teeth for a considerable time, and occasion a violent inflammation, which often proves fatal. The simple operation of cutting the gum removes the inflammation, and gives a free passage to the teeth.

The canine or dog-teeth, which are four in number, and situated next to the cutting-teeth, generally appear in the ninth or tenth month. About the end of the first, or during the course of the second year, the sixteen molars or grinders, four on each side of the canine-teeth, cut the gums. But these periods vary greatly in different children.

The cutting-teeth, the dog-teeth, and the first four grinders, are generally shed during the fifth, sixth, or seventh year; and are commonly replaced in the seventh year, though sometimes not before the age of puberty. The shedding of these sixteen teeth is occasioned by the expansion of the rudiments of a second set, which are situated at the bottom of the sockets, and, by

their growth, push out the first set. But there is no second set below the other grinders ; and, therefore, they never shed but by accident, and their loss is seldom repaired.

There are still other four teeth situated at the extremity of each jaw. In some persons, these teeth are entirely wanting : They seldom appear before the age of puberty, and sometimes not till a more advanced period. They are distinguished by the name of *Wisdom-teeth*, and either appear successively, or two at a time. It is owing to this irregularity in the wisdom-teeth, that the number of teeth is not uniformly the same, which varies from 28 to 32. Women, it has been alledged, have generally fewer teeth than men.

Some authors maintain, that the human teeth, like those of certain animals, would continue to grow during life, if they were not constantly worn down by grinding the food. But this notion seems to be contradicted by experience ; for people who live upon liquid food have not longer teeth than those who eat the hardest kinds of aliment. Besides, those who hold this opinion probably mistake the tusks of certain animals for their teeth. The tusks of the wild boar, and of the elephant, for example, continue to grow during life ; but their increase, after they arrive at their natural size, is extremely doubtful. Tusks have a greater analogy to horns than to teeth : But this is not a proper place

place for such discussions. We shall only remark, that, in children, the first set of teeth are less solid, and more loosely fixed in their sockets, than the second.

It has been often asserted, that the first hair of children is always brown ; and that, after it falls off, it is replaced by hair of different colours. I am unable to determine whether this remark be well founded ; but the hair of most children is fair, and often entirely white. In some it is red, and in others black : But in all those who are to have fair or brown complexions, the hair is more or less fair in early infancy. Those who are to be fair have generally blue eyes ; those who are to be red have yellowish eyes ; and those who are to be brown have eyes of a dark yellowish colour : But these distinctions are imperfectly marked in children recently after birth ; because their eyes are then almost always blue.

When infants are allowed to cry long and violently, ruptures are frequently the consequence of the efforts they make. These are easily reduced by the application of bandages. But, if this remedy be too long neglected, the disease may continue during life. The limits to which I have prescribed myself permit me not to mention all the diseases incident to children. I shall only remark on this subject, that worms, with which they are often infested, are produced from the nature of their food. Milk is a species

species of chyle, a purely nutritive substance, without any mixture: It, of course, consists entirely of organic and prolific matter, which, when not properly digested by the stomach, and applied to the nourishment and growth of the body, assumes, by its natural activity, other forms, and produces animated beings, or worms, in such profusion, that the child is often in danger of being destroyed by them. The bad effects occasioned by worms might perhaps be prevented, by allowing children to drink a little wine; because fermented liquors have a tendency to prevent the generation of worms: Fermented liquors likewise contain few organic nutritive particles; and it is chiefly by acting on the solids, that wine communicates strength to the body; for it contains little nourishment. Besides, most children are fond of wine; or, at least, they are easily accustomed to drink it.

Though the bodies of infants be extremely delicate, they are less sensible of cold than at any other period of life. Their internal heat, it would appear, is proportionally greater: The quickness of the pulse in children seems to fortify this opinion. Small animals, for the same reason, have unquestionably more heat than large ones; for the action of the heart and arteries increases in proportion to the comparative smallness of animals, which takes place in the same, as well as in different species. The pulse of an infant, or of a little man, is more frequent than that

that of an adult, or of a large man. The pulse of an ox is slower than that of a man ; a dog's pulse is quicker than a man's ; and the motion of the heart in very small animals, as that of a sparrow, is so rapid that the strokes can hardly be numbered.

The life of a child, till it be three years of age, is extremely precarious. In the two or three succeeding years, however, its life becomes more certain ; and, in the sixth or seventh year, a child has a better chance of living than at any other period. By consulting Simpson's tables of the degrees of mortality at different ages *, it appears ; that, of a certain number of children born at the same time, more than a fourth of them died in the first year, more than a third in two years, and at least one half in the first three years. If this calculation be just, when a child is born, we might lay a bet, that it would not live above three years. This exhibits a melancholy view of the human species ; for, though a man who dies at the age of 21 is generally lamented, as being prematurely deprived of life ; yet, according to these tables, one half of mankind must die before the termination of three years ; and, consequently, every man who lives more than three years, instead of complaining of his fate, ought to consider himself as peculiarly favoured by his Creator. But this mortality of children is not nearly so great in every place

* See Simpson's tables, published at London in 1742.

place as in London: M. Dupré de S. Maur has demonstrated, by a number of experiments made in France, that one half of the children born at the same time are not extinct in less than seven or eight years; and, therefore, we might insure the life of a new-born child for seven or eight years. When a child arrives at five, six, or seven years, it appears, from the same experiments, that its life is more certain than at any other age; for we may then insure for 42 years more. But, in proportion as it advances above five, six, or seven years, the number of years it will probably live constantly decreases. At 12, for instance, the chance is equal for 39 years only, at 20 for $33\frac{1}{2}$, at 30 for 28, and so on, till the age of 85, when the chance is equal for three years more *.

In the growth of the human body, one thing is exceedingly remarkable. The growth of the foetus increases more and more, in equal times, till it escapes from the womb. The growth of the child, on the contrary, gradually diminishes, in equal times, till the age of puberty, to which it makes a sudden bound, and soon acquires its full stature. The foetus, at the end of the first month, is an inch long; at the end of the second it is two inches and a quarter; in three months it is three inches and a quarter; in four months it is more than five inches; in five months

* See the tables at the end of this volume.

months, it is six and a half, or seven inches ; in six months, it is eight and a half, or nine inches ; in seven months, it is more than 11 inches ; in eight months, it is 14 inches ; and in nine months, it is 18 inches. Though these measures vary in different subjects, yet the uniform result is, that the foetus, in equal times, continues to have a proportionally greater increase. But, if a child at birth be 18 inches long, it will not acquire, for the next 12 months, above six or seven inches more ; that is, at the end of the first year, it will be 24 or 25 inches ; in two years it will only be 28 or 29 inches ; in three years it will be no more than 30, or, at most, 32 inches ; and afterwards, till the age of puberty, it will not acquire above one and a half, or two inches, every year. Thus the foetus grows more in one month, when near the termination of its abode in the uterus, than the child does in one year, till it arrives at the age of puberty, when Nature seems to make a sudden effort to bring her work to maturity.

For preserving the health of children, virtuous and wholesome nurses are of the utmost importance. We have too many melancholy examples of certain diseases being communicated from the nurse to the child, and from the child to the nurse. Whole villages have, in this manner, been infected with the venereal virus.

Children, it is probable, would be much more strong and vigorous, if they were nursed by their

their mothers, whose milk must be more agreeable to them than that of any other woman; for the foetus is nourished in the womb with a liquor which has a great resemblance to the milk in the breasts. Thus the infant is, in some measure, accustomed to the milk of the mother, even before its birth. But the milk of another woman is not only new to the child, but is often of so different a nature, that it is difficult to reconcile the child to the use of a stranger's milk. We sometimes see children, who cannot digest the milk of certain women, languish and turn diseased; and, if they are not speedily supplied with another nurse, they soon perish.

Nothing can be more destructive to children than the practice of crowding numbers of them into the same hospital. Most of them die of infectious diseases, which they would certainly escape, if they were brought up in separate houses, and particularly at a distance from great towns. The same expence would be sufficient to support them; and numberless citizens, which constitute the riches of a state, would, by this simple and natural mode of treatment, be saved to the public.

Children begin the difficult task of learning to speak about the 12th or 15th month. They pronounce the vowel A with most facility, because it requires only the opening of the mouth, and forcing out the air. E requires the tongue

to

to be raised, at the same time that the lips are opened. In pronouncing I, the tongue is still more elevated, and approaches the teeth of the upper jaw. O requires the tongue to be depressed, and the lips contracted ; and, in the pronunciation of U, the lips must be still more contracted, and somewhat extended. The first consonants articulated by children are those which require the least motion of the organs. B, M, and P, are most easily pronounced. B and P require only the lips to be joined, and then opened with celerity ; and for M, they must be first opened, and then quickly shut. The articulation of the other consonants cannot be effected without more complicated movements. The pronunciation of C, D, G, L, N, Q, R, S, and T, depends upon particular motions of the tongue, which are not easily described. F requires a prolongation of sound beyond any of the other consonants. Thus, of the vowels, A is most easily pronounced ; and, of the consonants, B, P, and M. It is for this reason that children, in all countries, first begin to articulate the words *Baba*, *Papa*, *Mama*. These words are the most natural, only because they are most easily pronounced ; and the letters of which they are composed must exist in every language.

It is worthy of remark, however, that, as the sounds of several consonants are very similar, as those of B and P, of C and S, of K and Q, of

D and T, of F and V, of G and J, of G and K, and of L and R, there may be many languages in which these different consonants are not employed. But, in every language, a B or a P, a C or an S, a K or a Q, a D or a T, an F or a V, a G or a J, an L or an R, are indispensable ; and, in the most contracted alphabets, there must be at least six or seven consonants ; because the articulation of them is not complicated, and the sounds by which they are uttered are all distinct and different from each other. Children who cannot easily pronounce R, substitute L in place of it, and T in place of D ; because the former are more difficult to articulate than the latter : And the softness or harshness of a language depends on the choice of consonants which are more or less difficult to pronounce. But it is needless to enlarge upon this subject.

Some children, at two years of age, articulate distinctly, and repeat whatever is said to them ; but most children require a long time. It has been remarked, that those who are long before they learn to speak, never articulate with the same facility as those who acquire that faculty more early. The latter may be taught to read before they are three years of age ; and I have known children read amazingly at four. But, after all, it is difficult to determine whether any advantages are to be derived from such premature instruction. We have had so many examples of prodigies

prodigies of learning at four, at eight, at twelve, and at sixteen years, who turned out to be either fools, or men of very little ability, at twenty-five, that I am inclined to think, that the common mode of education, by which Nature is not prematurely forced, and which is discreetly proportioned to the strength and capacity of children, is still the best.

S E C T.

S E C T. III.

Of Puberty.

PUBERTY commences where childhood ends, and accompanies us through the after periods of life. Before puberty, Nature seems to have had nothing in view but the growth and preservation of her work. The provision she has made for the infant extends no farther than the nourishment and expansion of its members. It lives, or rather enjoys a kind of vegetable existence, which is confined to itself, and which it cannot communicate. But the principles of life soon multiply : We are soon possessed of a stock, sufficient not only for our own being, but for enabling us to bestow existence upon others. This redundancy of life, the source of health and vigour, can no longer be confined, but is strongly impelled to expand and diffuse itself. The age of puberty is accompanied with several external and internal marks. It is the spring of life ; the season of pleasure. May we be enabled to write the history of this critical period, without exciting any ideas but what are strictly philosophical !

In

In the history of man, puberty, circumcision, castration, virginity, impotence, and many other circumstances, are articles too essential to be omitted. We shall, therefore, endeavour to describe them with that delicacy of style, that philosophical apathy, which annihilate every loose desire, and bestow on words nothing more than their simple and primitive signification.

Circumcision is a custom of great antiquity, and is still practised over the greatest part of Asia. Among the Hebrews, the operation was performed eight days after birth. In Turkey it is delayed to the seventh or eighth year, and sometimes to the eleventh or twelfth. The children in Persia are circumcised at the age of five or six; the wound is healed with caustic or astringent powders; and burnt paper is very generally used, which according to Chardin is the best remedy. This author tells, that the operation, when performed on grown persons, is attended with considerable pain: That they are obliged to be confined to the house three or four weeks; and that death is sometimes the consequence.

In the Maldivia islands, children are circumcised at the age of seven years. To render the skin soft, the children are bathed in the sea six or seven hours before the operation. The Israelites made use of a sharp stone: The Jews observe the same mode in most of their synagogues. But the Mahometans employ a knife or a razor.

An operation similar to circumcision is necessary in certain diseases. It is a common opinion, that the prepuces of the Turks, and of other nations where circumcision is practised, would naturally grow too long, if they were not curtailed in childhood. Boulaye says, that he has seen, in the deserts of Arabia and Mesopotamia, on the banks of the Tigris and Euphrates, numbers of Arabian boys whose prepuces were so long as to render them incapable of generation, without the aid of circumcision.

The people of the east have likewise longer eye-lids than the inhabitants of other nations. The skin of the eye-lids resembles that of the prepuce. But what relation can take place between the growth of those distant parts?

Girls as well as boys are circumcised, upon the borders of the Persic Gulph and the Red Sea. But these people never perform the operation till the girls have passed the age of puberty ; because there is no redundancy before that period. In other climates, the excess of growth in the nymphæ appears more early ; and is so general among certain people, as those upon the river Benin, that they circumcise both girls and boys eight or ten days after birth. The circumcision of females was an ancient custom, even in Africa. Herodotus mentions it among the usages of the *Æthiopians*.

Circumcision may, therefore be founded on necessity ; it has, at least, propriety for its object,

ject. But *infibulation* * and castration must have arisen from jealousy alone. These ridiculous and cruel operations have been invented by gloomy and fanatical tyrants, who, actuated by a mean envy, and a desire of monopolizing natural pleasures, enacted and enforced those barbarous and bloody laws, which make privation a virtue, and mutilation meritorious.

Boys are infibulated by drawing the prepuce forward, piercing it, and putting a small cord through the holes, which remains till the cicatrice of the opposite sides be formed: The cord is then removed, and a ring substituted in its place, which is made of sufficient strength to last as long as the person who ordered the operation pleases; and sometimes it remains for life. The eastern monks, who take on the vow of chastity, employ a large ring, which renders a breach of their oath impossible. We shall afterwards mention the method of infibulating females. It is impossible to imagine any thing too ridiculous upon this subject, which has not been practised by some men, either from motives of passion or of superstition.

During infancy, there is sometimes but one testicle in the scrotum, and sometimes none. We must not, however, conclude that children in this situation are totally destitute of these parts. It often happens, that the testicles remain in the

Cc 2 abdomen,

* This word signifies the operation of tying or sewing parts together.

abdomen, or are entangled in the rings of the muscles. But time generally removes these obstacles; and the testes descend into their proper receptacle at the age of eight or ten, and sometimes not till the season of puberty. Parents, therefore, have no reason to be anxious about such of their children as seemingly have no testes, or but one. The testicles of adults are seldom concealed; because nature, at the age of puberty, makes strong efforts to bring them to light. The same effect is sometimes produced by disease, or violent motion, such as a leap, a fall, &c. Even when the testicles never make their appearance, the purposes of generation are not frustrated. Men of this kind are often endowed with uncommon vigour.

There are men who have but one testicle. This defect, however, is inoffensive; for it is always uncommonly large. Some men have three, and are, on that account, said to possess more vigour and bodily strength. We learn, from the animal creation, how greatly these parts contribute to strength and courage. How different is an ox from a bull, a wedder from a ram, and a capon from a cock?

The practice of castration among mankind is very extensive, and of great antiquity. It was the punishment of adultery among the *Ægyptians*. In the Roman dominions, the number of eunuchs was considerable: At this day, these mutilated males are employed through all Asia and

and part of Africa, as guards upon the chastity of the ladies. In Italy, this infamous, this cruel operation, has nothing for its object but the improvement of the voice. The Hottentots cut off one testicle, because they imagine that this operation renders them more swift in the chase. In other countries, the poor people mutilate their children, to make them incapable of procreation, and to prevent them from feeling those excruciating pangs which they themselves suffer, when they want bread to support their offspring.

The species of castration vary according to the object in view. When the improvement of the voice is intended, the two testicles are only cut out. But men, whose minds are inflamed with jealousy, would not believe their females to be safe in the custody of such eunuchs : They employ none but such as have been deprived of the whole external parts of generation.

But amputation is not the only means of accomplishing this end. Formerly, the growth of the testicles was prevented, and their structure destroyed, without any incision : They bathed the infants in warm water and decoctions of plants, and then pressed and rubbed the testicles for a long time, in order to destroy their texture. Others compressed them with an instrument : Some pretend, that this species of castration does not endanger life.

The amputation of the testicles is not very dangerous : It may be done at any age ; the

time of infancy, however, is always preferable. But the amputation of the whole external parts of generation is often fatal, especially if performed after the age of fifteen years. Even in the most favourable time, which is from seven to ten years of age, there is always great danger. The difficulty of preserving eunuchs of this kind renders them exceedingly precious. Tavernier informs us, that, in Turkey and Persia, they bring five or six times the price of the other kind. Chardin observes, that the total amputation is accompanied with the most exquisite pain ; that it is performed pretty safely upon young children ; and is exceedingly dangerous after the age of fifteen ; that hardly a fourth part escape with life ; and that the wound is never cured in less than six weeks. On the other hand, Pietro della Valle asserts, that those who suffer this punishment in Persia for rapes, and other crimes of that nature, heal easily, though advanced in years ; and that they apply nothing but ashes to the wound. I know not whether those who underwent the same punishment in Egypt, as Diodorus Siculus relates, escaped with equal ease. According to Thevenot, vast numbers of negroes, who are forced by the Turks to submit to this operation, perish, even when it is performed on children of eight or ten years of age.

Beside negro eunuchs, there are others at Constantinople, throughout all Turkey, Persia, &c. who, for the most part, are brought from the

the kingdom of Golconda, the peninsula on this side the Ganges, the kingdoms of Assan, Aracan, Pegu, and Malabar, where their colour is gray ; and from the Gulf of Bengal, where they are of an olive colour : There are some white eunuchs from Georgia and Circassia ; but their number is small. Tavernier says, that, when he was in the kingdom of Golconda, in the year 1657, 22000 males were castrated. The black eunuchs come from Africa, and especially from *Æthiopia*. In proportion to the ugliness and horror of their appearance, they are the more esteemed, and bring a higher price. A very flat nose, a frightful aspect, large thick lips, and, above all, black teeth placed at a great distance from each other, are admired qualities in a eunuch. These people have commonly fine white teeth : But such teeth would be a capital defect in a eunuch, who ought to be a hideous monster.

Eunuchs, who are only deprived of their testicles, have a lively sense of titulation in what remains : They have even the external sign more frequently than other men. The part which remains, however, is generally small ; for it continues nearly in the same state in which it was before the operation. A eunuch castrated at seven years of age, when arrived at 20, is no better, with regard to this matter, than a child of seven. Those, on the other hand, who have not undergone the operation till the age of puberty,

berty, or later, have parts nearly equal to those of sound men.

Peculiar relations subsist between the throat and the parts of generation, though we are totally ignorant of their causes. Eunuchs have no beard ; their voice, though strong and piercing, can never reach a low or deep tone. Secret diseases often appear in the throat. The remarkable sympathy which some parts of the body have with others, though at a distance, and of a different nature, is a subject too much neglected : We are apt to despise effects, when we cannot easily discover their causes. Hence it is, that we never think of examining these relations or sympathies, although they are the proper spring of the animal constitution. In females, there is a remarkable sympathy between the uterus, breasts, and head. How many curious and useful facts of this nature might be discovered, if physicians paid more attention to this interesting subject ? It would produce more enlightened views, and a more extensive utility, than can ever be expected from a mere register of anatomical names. It is impossible to discover the principles of animal motion : The springs which give life to organization are not to be found in the muscles, veins, arteries, and nerves, described with such minuteness by anatomists. Organized bodies are possessed of internal powers, upon which the gross laws of mechanism have no influence. Instead of attempting to discover these

these powers, by attending to their effects, they have been treated as ideal existences ; they have ceased to be the objects of philosophical research. They have at last reassumed their native importance in the laws of gravitation, in elective attractions, in the phaenomena of electricity, &c. But, notwithstanding the evidence and universality of their existence, as their action is internal, as they are solely objects of reason, and have little connection with the senses, they are in danger of escaping our observation, and we admit them with difficulty ; for judgment is generally occupied and directed by external objects. We never imagine that the internal constitution of animated beings ought to be a principal object of inquiry. We conceive that the human genius is limited to external objects ; and, therefore, we overlook every thing that might lead to a more refined and spiritual philosophy.

The ancients, less limited in genius, and possessed of a more comprehensive philosophy, were not astonished to meet with facts which were inexplicable : They viewed Nature through a more transparent medium. A peculiar correspondence or sympathy, was to them only a phaenomenon ; but, to us, because not reducible to some fanciful laws of motion, it is a paradox. They knew that Nature produced her principal effects by laws concealed from human eyes : They knew, that, to trace her various laws and modes

modes of operation, exceeded the powers of our circumscribed faculties. A certain number of uniform and related effects, therefore, was to to them sufficient to constitute a cause, or law of nature. Whether, according to the ancients, this sympathy shall be called a peculiar correspondence between different parts of the body, or, according to the moderns, it shall be considered as an unknown relation in the action of nerves, its existence in the animal oeconomy is universal ; its effects, therefore, are of the utmost importance to the theory of medicine, and cannot be too diligently scrutinized. But this is not the place for a full investigation of such an important subject. I shall only observe, that the relation between the voice and the generative organs takes place not only in eunuchs, but in other men : It is even discoverable in females. In men, the voice changes at the age of puberty ; and in women, who have a strong rough voice, the passion of love is suspected to be violent.

The first symptom of puberty is a sense of fullness and stiffness in the groins, which is most perceptible when walking, or when the body is bent forward. This stiffness is often accompanied with pretty smart pain in the different joints of the limbs : It is likewise accompanied with a new and peculiar sensation in those parts which distinguish the sexes. Small whitish tubercles also begin to appear in these parts, which are the germs of their natural veil. The voice, for a considerable time, is rough and unequal ; after which

which it becomes more full, articulate, and strong. This change is very conspicuous in boys ; but it is less distinguishable in girls, because their voices are naturally more sharp.

These marks of puberty are common to both sexes : But each sex has marks peculiar to itself ; as the eruption of the menses, and the expansion of the breasts in women ; the beard and faculty of procreating in men. These marks, indeed, are not always uniform. The beard, for example, does not always appear precisely at the age of puberty : There are even whole nations who have hardly any beard. On the contrary, there is no country where the age of puberty in women is not distinguished by the enlargement of the breasts.

Among every race of mankind, the females arrive at puberty sooner than the males. But the age of puberty is very different in different countries. It seems to depend upon the temperature of the climate and the quality of the food. The children of citizens and of opulent parents, who are generally fed with rich and nourishing viands, arrive sooner at this state. But children brought up in the country, or whose parents are poor, require two or three years longer ; because their food is not only bad, but given too sparingly. In the southern parts of Europe, and in cities, girls arrive at puberty about the age of 12, and boys about 14. But, in northern climates, and in the country, girls hardly come

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to maturity till they are 14, and boys not before 16.

It may be asked, Why are the females, in all climates, capable of procreating sooner than the males ? The answer is easy : The bodies of men are larger and stronger ; their bones are harder, and their muscles more compact ; a longer time is therefore necessary for their growth. Besides, as the growth of the body must be nearly complete before a superfluous quantity of organic juices can be accumulated in the parts destined for generation, women, of course, must arrive at maturity sooner than men.

In the warmest climates of Asia, Africa, and America, the age of puberty commences in girls at ten, and sometimes at nine. The periodic discharge, though less abundant in warm climates, appears much sooner. The interval is nearly the same in all nations. With regard to time, a greater diversity takes place between individuals than between nations. In the same climate and nation, some females suffer this evacuation every 15 days ; others have an interval of six weeks : But a month, or a few days more or less, is the most usual period.

The quantity evacuated seems to depend upon the quantity of nourishment and of insensible perspiration. The discharge is greatest in females who eat largely and take little exercise : It is least in warm countries, where the perspiration is more copious. The quantity of this discharge

discharge has been variously estimated. It is, indeed, difficult to make an accurate measure. In different subjects, and different circumstances, it varies from one or two ounces to a pound, and even more. It generally continues to flow three, four, or five days; but sometimes it remains for six, seven, and even eight days. The cause of this discharge is generally ascribed to a superfluity of bloody and nutritious juices. The symptoms which precede it are certain indications of a plethora, as heat, tension, swelling, and the pains felt not only in the parts themselves, and their environs, but in the mammae, which also swell, and discover a superabundance of blood by the colour of the areolæ becoming then more deep: The eyes likewise are heavy, and the skin below the orbits takes on a faint blue or a violet colour: The cheeks glow; the head is heavy and affected with pain; and, in a word, the whole body is oppressed with a surcharge of blood.

The growth of the body, in length, generally terminates at the age of puberty. Before this period, young people commonly shoot up several inches in a very short time. But the quickness of growth is most remarkable in the parts of generation of both sexes. In males, this growth is only an augmentation in size: But, in females, it often produces a shrinking of some of the parts, which has received different appellations from

from those who have treated of the signs of virginity.

Men, jealous of pre-eminence of every kind, have always discovered a remarkable attachment to prior and exclusive possessions. This species of folly has bestowed a physical existence upon female virginity. Virginity, which is a moral being, a virtue existing solely in purity of heart, has been metamorphosed into a physical object, in which most men think themselves deeply interested. This notion, accordingly, has given rise to many absurd opinions, customs, ceremonies, and superstitions; it has even given authority to pains and punishments, to the most illicit abuses, and to practices which shock humanity. Young women have been obliged to submit to the examinations of ignorant matrons, and to expose the secrets of nature to the eyes of prejudiced physicians. They did not reflect, that every indecency of this kind is a violent attack against chastity; that every situation which produces an internal blush, is a real prostitution.

I have little hope of being able to eradicate the ridiculous prejudices which have been formed on this subject. Mankind always believe what they wish to be true, however vain and unreasonable the foundations of their faith. But, as it is the province of history to relate not only the succession of events, and the circumstances of facts, but likewise the origin of popular opinions and errors, I think it a necessary article in

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the history of man, to examine this favourite idol which he adores, to consider the reasonableness of his worship, and to inquire whether Virginity be a real or a fabulous divinity.

Fallopis, Vesalius, Diemerbroek, Riolan, Bartholin, Heister, Ruysch, and some other anatomists, maintain, that the membrane of the hymen has a real existence, and that it ought to be reckoned among the parts of generation peculiar to females. They assert, that it is a fleshy membrane, very thin in infants, but thicker in adults; that it is situated under the orifice of the urethra, and nearly shuts up the entrance of the vagina; that it is perforated by a round or oval hole, so small as hardly to admit a pea during infancy, or a large bean at the age of puberty. The hymen, according to Winslow, is a membranous fold, sometimes circular, and sometimes semilunar, with an aperture of a smaller or greater size in different subjects, &c. On the other hand, Ambrose Paré, Dulaurent, De Graaff, Pineus, Dionis, Mauriceau, Palfyn, and other anatomists of equal authority with those formerly mentioned, insist, that the membrane of the hymen is a mere chimera; that it is not natural to young girls; and express their astonishment that any man should talk of it as a thing which has a real and uniform existence. They produce a multitude of experiments and observations made upon subjects of different ages, in which they could never discover any appearance

of this membrane. They acknowledge, that they have sometimes, but very seldom, seen those fleshy protuberances called carunculae myrtiformes connected by a membrane; but they maintain that this membrane was preternatural. Anatomists are not less divided with regard to the number and qualities of these carunculae. Are they only rugosities of the vagina? Are they distinct and separate parts? Are they the remains of the hymen? Is their number uniform? Does only one, or many, accompany the state of virginity? All these questions have been stated, and each has received a different solution.

This opposition of sentiment, in a matter which depends on inspection, is an incontestible proof, that mankind have often an ardent desire to discover things in Nature which exist in their own imaginations only. Many anatomists of reputation have never been able to discover either the hymen or carunculae, even before the age of puberty. Those who support the contrary opinion, at the same time acknowledge, that these parts are not always the same; that their form, size, and texture, vary in different subjects; that, in place of the hymen, sometimes there is but one caruncula, at other times there are two or more united by a membrane; that the shape of the aperture is not uniform, &c. What is the consequence? We must conclude, that the causes of this mark of virginity are equivocal and inconstant; and that, even

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when they have existence, they produce only an effect of a transient and variable nature. Anatomy determines nothing with regard to the existence of the hymen and carunculae ; it allows us to reject these symptoms of virginity, because they are not only uncertain, but imaginary.

The effusion of blood, though a more common symptom, is not less equivocal. It has, in all ages been regarded as an infallible proof of virginity. But it amounts to nothing, in all those cases where the entrance of the vagina is naturally relaxed or dilated. Besides, the effusion of blood is not peculiar to virgins. Women who have no pretensions to virginity frequently experience this discharge. Some discharge copiously and often ; others a small quantity, and only once ; and some have no such effusion. This phaenomenon depends upon age, health, structure of parts, and a number of circumstances. Of these we shall enumerate only a few, and endeavour, at the same time, to investigate the true causes of the various physical marks which have been held forth as infallible characteristics of female virginity.

At the time of puberty, the parts of both sexes undergo a considerable change : Those of the male have then a growth so quick, that they arrive in a year or two at full maturity. Those of women increase likewise at this period. The nymphæ, in particular, which, though formerly almost imperceptible, now become full and con-

spicuous. The menstrual discharge appears at the same period. By an unusual accumulation of blood, all the parts swell, and approach towards each other. The orifice of the vagina contracts, though the dimensions of the vagina itself be enlarged. The appearances produced by this contraction are different in different subjects; for we are informed by anatomists, that there are sometimes four and sometimes only three, or two, *carunculae*; and that a circular or semilunar ring, or rather a series of folds, is a common phaenomenon. But anatomists have neglected to tell us, that, whatever form this contraction assumes, it never appears before the age of puberty. In young girls whom I have had occasion to dissect, nothing of this kind could be discerned; and, having collected many facts concerning this subject I can with confidence assert, that when young women, before puberty, have commerce with men, no effusion of blood ever happens, unless the parts be greatly disproportioned, or some violence is committed. On the other hand, at the time of puberty, especially when the females are regular, and in good health, these effusions are common, and produced by the slightest causes. But those who are meagre, and subject to the *fluor albus*, generally want this mark of virginity. The frequent repetition of this flux of blood, and even at considerable intervals of time, is an evident demonstration that it is only a deceitful appearance.

ance. It is a certain fact, that young women, who at first had a copious effusion, have repeated this pretended symptom of virginity after a few months abstinence. This phaenomenon may, by proper management, be frequently exhibited, especially before the body has acquired its full growth. It is equally certain, that young women, who have not been faithful to the marriage-bed, have, notwithstanding, by the simple expedient of abstinence, given fresh proofs of innocence to their deluded husbands. Some women, in the course of two or three years, have exhibited this fictitious mark of purity five times. But this symptom is limited to a certain time; for it seldom appears after the age of eighteen years. When the growth of the body is completed, its parts become fixed and unalterable, and cannot assume differences but by the employment of such artifices as it would be both unnecessary and improper to relate. Besides, many women, particularly those who are irregular in their menses, and subject to the *fluor albus*, never have any fresh marks of virginity.

Nothing, therefore, can be more chimerical than the prejudices of men with regard to virginity, and nothing can be more fallacious than its pretended signs. A young woman may have commerce with a man before the age of puberty, and yet exhibit no marks of virginity. But the same woman, after she arrives at puberty, may have very copious effusions of blood.

Others, who are actual virgins, discover no such appearances. Men, therefore, should be perfectly easy as to this matter, and not indulge, as is too often the case, unjust and ridiculous suspicions.

If we wish to obtain an evident and infallible mark of virginity, we must search for it among those barbarous people, who are incapable of instilling by education the sentiments of virtue and honour into their children, but secure the chastity of their daughters by an expedient which could only be suggested by the rudeness of their manners. In Æthiopia, and other parts of Africa, in Pegu, Arabia Petrea, and other nations of Asia, the inhabitants, immediately after the birth of females, sew up those parts which Nature has separated, leaving only a space sufficient for the natural evacuations. As the child grows, the parts gradually adhere, and, when the time of marriage arrives, they are again disunited by incision. Instead of thread, the fibres of the asbestos are said to be employed, which is a substance not liable to sudden corruption. Some tribes content themselves with putting a ring through the parts. To this operation wives as well as girls are subjected, with this difference, that the ring allotted to the latter cannot be removed, but, in that allotted to the former, there is a lock, of which the husband alone possesses the key. But why should we mention barbarous nations, when we have similar examples at

no great distance? That absurd delicacy of a neighbouring nation, with regard to the chastity of their wives, is the offspring of a brutal and criminal jealousy.

How opposite are the tastes, the dispositions, the opinions, and the manners of different nations? After what has been related concerning the high estimation of virginity among the bulk of mankind, and the numberless precautions and ignominious methods employed to secure it, is it possible to believe that there are other people who despise virginity, and consider the trouble of removing it to be a mean and servile office?

Superstition has induced the inhabitants of certain countries to resign the first fruits of virginity to their idolatrous priests, and sometimes to the idols themselves. This privilege is enjoyed by the priests of Cochin and of Calicut; and, in Goa, the virgins are prostituted by their parents, either voluntarily or from choice, to an idol of iron. Gross superstition induces these people to commit such abominable outrages from religious motives. But views more servile and interested have induced men of other countries to devote their daughters to their chiefs. The inhabitants of the Canary isles, and of the kingdom of Congo, prostitute, in this manner, their daughters, without any injury to their reputation. Nearly the same custom takes place in Turkey, Persia, and several other countries both of Asia and Africa. Their most eminent nobles

think themselves highly honoured to receive from their sovereign women with whom he himself is already disgusted.

In the kingdom of Arracan, and in the Philippine islands, a man would esteem it to be disgraceful to marry a young woman who had not been previously deflowered ; and nothing but the force of money can prevail on any person to precede the husband. In the province of Thibet, mothers anxiously search for strangers, and earnestly solicit them to put their daughters in a proper state for obtaining husbands. The Laplanders likewise prefer girls who have had commerce with strangers. They fancy them to possess uncommon merit, because they have been able to please men who are better judges of beauty and female accomplishments than themselves. In Madagascar, and several other countries, the most dissolute and debauched women are soonest married. Many other examples might be given of this strange taste, which nothing but the grossest and most depraved manners could produce.

After puberty, marriage is the natural state of man. A man ought to have but one wife, and a woman but one husband. This is the law of nature ; for the number of females is nearly equal to that of males. Such laws as have been enacted in opposition to this natural principle, have originated solely from tyranny and ignorance. Reason, humanity, and justice revolt

revolt against those odious seraglios, in which the liberty and the affections of many women are sacrificed to the brutal passion of a single man. Does this unnatural pre-eminence render these tyrants of the human race more happy? No! Surrounded with eunuchs, and with women useless to themselves and to other men, they are tormented with the constant appearance of that accumulated load of misery they have created.

Marriage, therefore, as it is established among us, and other nations who are directed by the lights of reason and revelation, is a state most consonant to the nature of man, and in which it is his duty to employ those new faculties he acquires from puberty. By obstinately persisting in celibacy, these powers become troublesome, and sometimes fatal. In either sex, too long continency may give rise to diseases, or create irritations so violent, that neither reason nor religion may be able to counteract the impetuosity of those passions they excite: And thus man may be reduced to a level with the brutes, which, under the influence of such sensations, become perfectly furious and ungovernable.

In women, the furor uterinus is the most violent effect of this irritation. This disease is a species of madness, which deranges their ideas, and deprives them of all sense of shame. Both the nature and the seat of this melancholy dis-
temper

temper are indicated by the most lascivious expressions, and the most indelicate actions. I have seen, with astonishment, a girl at the age of twelve years, who had a brown, but lively and florid complexion, and, though low in stature, was strong and plump, commit the most indecent actions upon the very appearance of a man, from which she could not be deterred, either by the presence or chastisement of her mother. She did not, however, lose her reason; and the paroxysms of the disease ceased, the moment she was left with her own sex. Aristotle alledges, that, at this age, the irritation is strongest, and that girls ought then to be carefully watched. The remark may be applicable to the climate in which he lived; but, in colder countries, the ardor of the female constitution does not appear so early.

When the furor uterinus increases to a certain degree, marriage will not remove it; and there have been instances of its proving fatal. Happily the force of nature is seldom the only cause of a passion so detestable, even when there is a predisposition to it in the habit of body. Before it arrives at this extremity, the imagination must be inflamed by licentious conversation, by obscene representations, or other causes. Among women, the opposite temperament is infinitely more common; for, with regard to this passion, most of them are either cool or indifferent. There are also many men to whom chastity is

an easy virtue. I have known some men who, at the age of twenty-five or thirty, enjoyed good health, without having ever felt this passion so strong as to render any gratification necessary.

Continency, however, is less to be dreaded than excess. The number of immoderate men is too great to require particular examples. By excess, some have lost their memory; some have been deprived of sight; some have become bald; and many have perished by pure debility. Young persons can never be sufficiently warned of the irreparable injury to their health, which the indulgence of the venereal appetite never fails to produce. How many cease to be men, or, at least, cease to enjoy the powers of manhood, before the age of thirty? and how many, at fifteen or eighteen, receive the seeds of a disease, disgraceful in itself, and which it is often impossible to eradicate?

It has already been remarked, that, at the age of puberty, the growth usually stops. It frequently happens, however, that, even after puberty, a tedious illness makes the body increase in length more than it would have done in a state of perfect health. This extraordinary increase is probably occasioned by the inactivity of the external organs of generation during the course of the disease. The organic particles do not reach these parts, because they are not determined thither by irritation; and this defect of irritation is owing to a lassitude and imbecility

lity of the parts, which prevent the secretion of the seminal fluid. These organic particles, therefore, remain in the mass of blood, and necessarily extend the extremities of the bones, nearly in the same manner as happens to eunuchs. Thus young people, after recovering from a long sickness, are often taller, but worse shaped, than formerly. Some, for instance, become hunch-backed, and others crook-legged ; because the still ductile extremities of the bones have been unnecessarily extended by a superfluity of organic particles, which, in a state of health, would have been exhausted in the formation of seminal fluid.

The production of children is the chief intention of marriage. But this intention is sometimes frustrated. Of the different causes of sterility, some are common to both sexes. But, as these causes are more apparent in men than in women, they are, therefore, more commonly ascribed to the former. In both sexes, sterility is occasioned either by a defect in the original conformation, or by accidental injuries done to the organs themselves. In men, the most pernicious defects of conformation are those which affect the testicles, or the muscles called *erectores penis*. A wrong direction of the urethra, which is sometimes not only oblique, but improperly perforated, is another obstacle to generation. The adhesion of the prepuce to the fraenum is another obstacle ; but it is not insurmountable.

In

In women, the conformation of the uterus may likewise occasion sterility. If the orifice of the uterus be always open, or always shut, conception will be equally prevented. But the most frequent cause of barrenness, both in men and women, arises from some depravity in their seminal fluids. I formerly quoted a remark of Valisnieri, that a corruption of the fluid in the testicles of women rendered them entirely barren. It is the same with men. If the secretion by which semen is formed be vitiated, the fluid is unfit for impregnation. These causes of sterility are not discoverable by any external appearances.

In cases of sterility, different means have been employed to discover whether the defect proceeded from the man or the woman. Inspection is the first resource ; and, if the barrenness be occasioned by a fault in the external conformation, it is sufficient. But, if the defect lie in the internal organs, it is hardly possible either to discover or remove it. Some men, though they appear to be perfectly formed, want the genuine sign of a proper conformation. Others have this sign so imperfectly, or so seldom, that it is only a very equivocal mark of virility.

Every body knows that the action of this part is not under the command of the mind. It is the most animal part of the human body ; for it acts by a kind of instinct, the causes of which are unknown. How many young persons, educated

duced in perfect purity, and totally ignorant of pleasure, have felt the most lively impressions, without being able to recognise either their cause or their object? How many, on the contrary, remain cold and languid, notwithstanding all the efforts of sense and imagination?

This part of our bodies, therefore, belongs less to us than any other of our members. It acts or is languid without our participation. Its functions commence or terminate at certain periods. All this happens without our command, and often contrary to our inclination.

Where, then, is the foundation for those laws, which are so unjust in their principle, and so disgraceful in their execution? The rules and decrees of the Congress* are an affront to human reason. Its members should have known, that the very means they employed to investigate truth, were not only indelicate, but infallibly prevented its discovery.

When there is no defect in the external conformation, barrenness proceeds oftener from the woman than the man; for, independent of the pernicious effects of the *fluor albus*, there seems

* The name of an infamous court in France, where trials for impotency, with a view to dissolve marriages, were held. Proofs by inspection were taken before the judge, who was assisted by surgeons and midwives. This court was abolished by an arrêt of the parliament of Paris, dated 18th February 1677. It is surprising that the Count de Buffon, who expresses the utmost detestation against this court, should have mentioned nothing of its dissolution.

seems to be another cause which has never excited attention.

From my experiments, related in the sixth chapter, it appears that the testicles of females give birth to a kind of natural protuberances, which I have called *glandulous bodies*. They grow in a gradual manner, and serve for secreting and maturing the seminal fluid. They are in a continual fluctuating state. They begin to grow under the membrane of the testicle, which they soon perforate; they then swell, and their extremities spontaneously open, and distill a seminal fluid for some time; after which they gradually decay, leaving only a small reddish cicatrice on the place from whence they sprung. These glandulous bodies no sooner disappear than they are replaced by others; so that the testicles are continually labouring, and undergoing considerable changes. Hence any derangement in these organs, either by an unusual thickness of the fluid, or weakness of the vessels, prevents the proper exercise of their functions, renders them unable to secrete, or rather vitiates and corrupts the seminal fluid, which necessarily gives rise to sterility.

Conception sometimes precedes puberty. Many women have become mothers before the appearance of the menses; and some who never had any symptoms of this evacuation, are in the habit of bearing children. Instances of this kind happen in our climate, without travelling for

for them to Brazil, where whole nations are said to be perpetuated, though not a single woman be subject to the menstrual discharge ; an evident proof that it is not the menstrual blood, but the seminal fluid of the male and female, which are essentially necessary to generation. It is likewise known, that the cessation of the menses, which generally happens about the age of forty or fifty years, does not disqualify every woman for conception ; for some women have become pregnant at sixty or seventy, and even at an age still more advanced. These examples, though pretty frequent, may be regarded as exceptions to the general rule ; but they are sufficient to demonstrate that the menstrual blood is by no means essential to generation.

In the ordinary course of Nature, women conceive not before the menses appear, nor after they have ceased. The age at which men first acquire the faculty of generating is not so distinctly marked. His body must attain a certain growth before semen is secreted ; and, before this fluid be fully matured, the degree of growth must be still greater. This generally happens between the twelfth and eighteenth years. But the period when man loses the generative faculty, Nature seems to have left undetermined. At sixty or seventy, when old age begins to enervate the body, the semen is less abundant, and often unprolific. In the collections of public societies, however, there are

many

many instances of men who have continued to procreate at the age of eighty and ninety.

There are likewise examples of boys who have procreated at eight, nine, and ten years, and of girls who have conceived at seven, eight, and nine years. But such facts are exceedingly rare, and ought to be regarded as singular phenomena. The sign of virility appears in infancy: But that is not sufficient; the production of semen must be added; and this happens not till the growth of the body is nearly completed. At first the quantity is small and generally sterile.

Two marks of conception have been mentioned by authors. The first is a kind of tremor, or shivering, which is said to begin at the moment of conception, and continues for some days. The second is derived from the orifice of the uterus, which, it is asserted, closes entirely after conception. But these signs appear to be very equivocal, if not altogether imaginary.

This tremor is mentioned by Hippocrates in the following terms: ' Liquido constat harum rerum peritis, quod mulier, ubi concepit, statim inhorrescit ac dentibus stridet, et auriculam reliquumque corpus convulsio prehendit.' Galen, on the authority of some women, imputes this symptom to the contraction of the uterus. Others express it by a vague sensation of cold over the whole body, and employ the words *horror* and *horripilatio*. These, and other authors,

thors, endeavour, like Galen, to establish the fact upon the testimony of women. Hippocrates says, ‘ quae in utero gerunt, harum os uteri ‘ clausum est ;’ or, according to another translator, ‘ quaecunque sunt gravidae, illis os uteri ‘ connivet.’ Opinions, however, are various as to the changes which the uterus undergoes after conception. Some maintain, that the edges of the *os tincae* are drawn so close together, that no vacuity is left between them ; and others affirm, that these edges are not exactly close till after the two first months of pregnancy. They agree, however, that, immediately after conception, the orifice is shut up by a glutinous humour ; that the *os tincae*, which, previous to conception, might admit a substance of the size of a pea, has no perceptible aperture ; and that this difference is so evident, as to be distinguishable by a skilful midwife. If these assertions were founded in truth, the state of pregnancy might be known a few days after conception.

It is urged, on the other hand, that if, after conception, the orifice of the uterus were closed, superfoetation would be impossible. To this it may be replied, that the seminal liquor may perhaps penetrate through the membranes of the uterus ; that the uterus itself may open to receive the materials necessary for superfoetation ; and that, at any rate, superfoetations so seldom happen, that they make a very trifling exception to the general rule. Other authors

maintain,

maintain, that this change in the uterus can never appear but in women who have formerly conceived and brought forth children. In first conceptions, indeed, the difference must be less perceptible; but, though ever so conspicuous, we have not sufficient evidence to conclude, that it is a certain, a uniform, and a positive sign. The study of anatomy, aided by experience, affords, on this subject, general notions only, which vanish upon a closer examination. The same observation may be applied to the shivering, or convulsive cold, which some women are said to feel at the time of conception. As most women experience not this sensation; as others, on the contrary, assure us, that they have felt a burning heat; and as others still confess that they are utter strangers to all such feelings; the natural conclusion is, that all these marks are highly equivocal, and that, when they do happen, they ought to be considered, not as the effects of conception, but of other causes.

On this subject I shall add one fact from Mr Parsons's lectures on muscular motion, p. 79. which proves, that the orifice of the uterus does not close immediately after conception, or, if it does close, that the semen may find a passage into the uterus, by penetrating its substance. In the year 1714, a woman of Charlestown in South Carolina, was delivered of two children, the one immediately after the other.

To the astonishment of the assistants, the one child was black and the other white. This evident testimony of the woman's infidelity to her husband, obliged her to acknowledge, that, one morning, her husband having just left her bed, a negro entered her chamber, and, by threats of immediate death, compelled her to gratify his desires. This fact shows, that the conception of two or more children does not always happen at one time, and supports my opinion, that the semen penetrates through the texture of the uterus.

There are many other equivocal signs of pregnancy, by which it is said to be early distinguishable; as a slight pain in the region of the uterus and loins; a numbness over the whole body; a continual drowsiness; a melancholy and capricious disposition; the toothach, headache; and a vertigo, which obscures the sight; yellowish, blood-shot eyes, with contracted pupils and depressed eye-lids; a pale and spotted countenance; a depraved appetite, accompanied with vomiting and spitting; hysterick symptoms; the fluor albus; the stoppage of the menstrual discharge, or, instead of it, an haemorrhage; the secretion of milk in the breasts, &c. Many other marks supposed to be peculiar to pregnancy might be added; but they are frequently nothing more than the effects of particular diseases. But we shall leave the discussion of these to physicians. Details of this kind, to be useful,

useful, would require a long series of profound investigation. This subject, like many others in physiology, in the animal oeconomy, and in different branches of the medical art, has seldom been treated with any degree of philosophical accuracy.

E e 2

S E C T.

S E C T. III.

Of Manhood.

AT the age of puberty, or a few years after it, the human body attains its full stature. The growth of some persons stops at the fourteenth or fifteenth year; and, in others, it continues till they arrive at twenty-two or twenty-three years. During this period, most men are of a slender make: Their thighs and legs are small, and the muscular parts are not properly filled up. But, by degrees, the muscles swell, the limbs and different parts of the body assume their proper figure and proportions, and, before the age of thirty, the body, in men, acquires its most perfect symmetry.

But, in women, the body sooner attains this symmetry. As their size is smaller, and their muscles, and other parts, less strong, compact, and solid, than those of men, they arrive more early at a state of maturity. A woman at twenty years is as perfectly formed as a man at thirty.

The body of a well-shaped man ought to be square, the muscles boldly marked, and the features of the face distinctly defined. In women, the parts are rounder and softer, and their features

are

are more delicate. Man is adorned with strength and majesty ; grace and softness are the peculiar embellishments of woman.

Even the external figure of the human species declares them to be the sovereigns of the earth. The body of man is erect ; his attitude is that of command ; and his countenance, which is turned towards the heavens, is impressed with the signatures of superior dignity. The image of his soul is painted in his face ; the excellence of his nature penetrates through his material form, and animates his features with a divine illumination. His majestic deportment, and the firmness of his movements, announce the superiority of his rank. He touches the earth with his extremity only : He views it at a distance, and seems to despise it. His arms are not pillars to support his body : His hands tread not the earth, and lose not, by friction and pressure, that delicacy of feeling for which they were originally destined. His arms and hands are formed for purposes more noble, namely, for executing the commands of his intellect, for laying hold of distant objects, for removing obstacles, for defending him from injuries, and for seizing and retaining objects at pleasure.

When the mind is at ease, all the features of the countenance are in a state of profound tranquility. Their proportion, their harmony, their union, point out serenity of sentiment, and accord with the calm that subsists within. When

the soul, however, is agitated, the human visage becomes a living canvas, upon which passions are represented with equal energy and delicacy ; where every emotion is expressed by a correspondent feature ; where every impression anticipates the will, and reveals, by obvious and pathetic characters, those intentions and feelings which we are solicitous to conceal.

It is in the eyes that the passions are most strongly marked, and most readily discovered. The eye belongs to the soul more than any other bodily organ. It participates of every mental emotion, the softest and most tender, as well as the most violent and tumultuous. It exhibits these emotions in all their force and purity, and infuses into the soul of the spectator the fire and the agitation of that mind in which they originate. In fine, the eye reflects the light of thought, and the glow of sentiment ; it is the sense of the understanding, and the language of intelligence.

Men who squint, or are short-sighted, have less of this external soul, (as it may be termed), whose chief residence is in the eye. These defects hurt the physiognomy, and give to the finest countenance a disagreeable, and often a stupid air. As nothing but strong and violent passions are discoverable in visages of this kind, and as they exhibit no marks of delicacy or vivacity of sentiment, we are apt to form unfavourable impressions of such persons, which, however

ill founded, it is difficult for us to efface. We are so accustomed to be influenced by external appearances, that, if no symptoms of thought and reflection appear in a man's countenance, we instantly decide him to be void of ability. We even draw conclusions from the cut of the clothes, or the curls of the periwig; neither are these conclusions always false. Men ought, therefore, to pay some attention to these minute articles; because, in the eye of strangers, they make a part of ourselves, and contribute not a little to the judgments they form of our understanding and breeding.

A vivacious or a languid motion of the eye has a prodigious effect on the character of the countenance. Eyes are of different colours, dark hazel, light hazel, green, blue, gray, and whitish gray. The iris has a smooth velvet-like appearance, and consists of many small filaments, regularly disposed, and directed towards the centre of the pupil. The most usual colours of the eye are the hazel and the blue; and both these colours are sometimes to be found in the same eye. The eyes commonly called black, when narrowly inspected, are only of a dark hazel colour. They appear black in consequence of their being contrasted with the white of the eye. Those of a less deep hazel are likewise reckoned black, but are not equally beautiful. Shades of orange, hazel, gray, and blue, are frequently to be met with in the same eye; but,

but, wherever there is a blue tint, it becomes the prevailing colour, and outshines all the rest. The black and the blue are the most beautiful colours, and give most fire and vivacity of expression to the eye. In black eyes there is more force and impetuosity; but the blue excell in sweetness and delicacy. The former dart forth a perpetual and uniform flame, because their colour appears always the same, and reflects the same rays: But the modifications of light are distinguishable in the blue; because different rays are reflected by the various tints of which they are composed.

These, and other varieties in the colours of the eyes, are peculiar to man, the horse, &c. In most other animals, the colours of individuals vary not. The eyes of the ox are brown; those of the sheep are of a watery colour; those of the goat are gray, &c. Aristotle alledges, that, among men, gray eyes are the strongest; that the blue are weaker; that prominent eyes are short-sighted; and that brown eyes see not so well as others in a faint light.

Though the eye, in moving, seems to be drawn towards either side, yet it only moves round its own centre, which gives the pupil the appearance of approaching or receding from the angles of the orbit, and of being elevated or depressed. In man the eyes are nearer each other than in any other animal. In some species, the eyes are so remotely situated, that it is impossible

possible for both eyes to see the same object at the same time.

Next to the eyes, the parts which give most character to the countenance are the eye-brows. Being totally different from every other feature, their effect is augmented by the contrast: They form a deep shade in the canvas, and give relief to the other colours and features. The lashes of the eye-lid have also their effect; when long and bushy, they bestow beauty on the eye, and give a mild and pleasant aspect to the face. Lashes on both eye-lids are peculiar to man and the ape. Other animals have hair on the upper lid only; and, even in man, the lash of the under lid is less than that of the upper. The eye-brows have only two movements; one by which they are elevated; and the other by which they are depressed and contracted.

The eye-lids guard the ball of the eye from dust, insects, &c. and keep the cornea moist. The upper eye-lid moves up and down; but the under lid has little or no motion. Although the motion of the eye-lids be subject to the will, yet, by sleep, fatigue, or surprise, we lose the command of them. They are sometimes also affected with convulsive motions, which we are unable to restrain. In birds and amphibious quadrupeds, the under eye-lid alone moves; and fishes and insects have no eye-lids either above or below.

The forehead occupies a large part of the face, and contributes greatly to its beauty. It should be well proportioned, neither too flat nor too prominent; neither too narrow nor too short; and it should be regularly adorned with hair both above and on each side. The hair gives great expression to the countenance; baldness is therefore a capital defect; and the practice of employing superficial hair, which is now so general, ought to be confined to such as are naturally bald; for borrowed locks often change the true character of the face. If every man wore his own hair, and allowed it to float freely, it would be more easy to distinguish characters by the general aspect of the countenance. The crown of the head, and immediately above the temples, are the parts which first become bald; but the hair below the temples, and on the under part of the back of the head, seldom falls off. Baldness is peculiar to man: Women, in the most advanced age, though their hair becomes white, are seldom affected with baldness: Children and eunuchs are not more subject to it than women; and the hair is stronger and more abundant in youth than at any other period. The longest hair becomes dry, and gradually wastes and falls off as we advance in life. The whiteness commences at the points; and, when the hair is totally white, it loses its strength, and at last falls off altogether. There have been examples of young people whose hair

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was rendered white by disease, and which recovered its natural colour after their health was restored. It is alledged by Aristotle, that no man becomes bald before having intercourse with women, except such as have been bald from their birth. The ancient writers upbraid the inhabitants of the islands of the Archipelago with the epithet *bald-heads*; and assert, that these islanders are all brought into the world with this defect *.

The nose is the most prominent feature in the face. But, as it has very little motion, even in the most violent passions, it contributes more to the beauty than to the expression of the countenance; and, unless it be deformed, or greatly disproportioned, it is less attended to than those features which are capable of motion, as the mouth and the eyes. The form of the nose, and its remarkable prominency, are peculiar to the human species. Most animals have nostrils separated by a partition; but none of them have an elevated and advanced nose. Even the apes may be said to have nostrils only; the nose of an ape has the same position as that of a man; but it is so short and flat, that it can hardly be regarded as similar. By this organ, men, and most animals, breathe, and smell odiferous bodies. Birds have no cartilaginous nostrils; they have only two holes or pipes for the purposes of respiration and smelling.

Next

* See Dapper's Voyage, p. 354. and Plin. edit. Hardouin, p. 541.

Next to the eyes, the mouth and lips have both the greatest motion and expression. These motions are excited by the passions, and the various forms of the mouth mark their different characters and modifications. The organs of speech give the mouth an animation superior to every other part of the face. The vermillion of the lips, and the whiteness of the teeth, so much excel the other colours of the face, that they attract our chief regard. We fix our eyes on the mouth of the speaker; every word, every articulation, produces different motions on the lips; and, however rapid, it is easy to distinguish them from each other. The deaf learn to distinguish these motions so accurately, that they often know the sentiments of the speaker merely by attending to the motions of his lips.

In man, and in all other animals, the under-jaw is alone endowed with the power of motion. The crocodile, the opinion of Aristotle and many other naturalists notwithstanding, is not an exception: I have examined many skeletons of that animal, and have found, by the nature of the articulation, that the under-jaw alone was moveable. In the human foetus, and in monkeys, the under-jaw is greatly advanced before the upper. The deformity, in adults, is equal, whether the under-jaw be too prominent, or too much depressed: It ought to be nearly on a level with the upper. Strong passions, as well as languor, often produce an involuntary motion

motion in the under-jaw : Pain and pleasure, as well as languor, give rise to yawning ; but, in the former, the motion is more brisk and lively.

When the mind is suddenly affected with ardent desire, or keen regret, we feel a sort of starting, or internal oppression ; this motion of the diaphragm elevates the lungs, and produces that sudden inspiration which forms a sigh : And, when the mind considers the cause of its emotion, and perceives no method of accomplishing its desire, or of banishing its regret, the sighs are repeated, and sorrow, or mental pain, succeeds. If this pain of mind be great and unexpected, it produces tears ; the air rushes quickly into the lungs, and gives rise to many inspirations, which are accompanied with involuntary shocks : Each inspiration makes a noise stronger than that of sighing, and is distinguished by the name of sobbing ; these sobs succeed each other more rapidly than sighs ; and, in the former, the sound of the voice is more apparent. The accent of the voice is still more distinguishable in groaning, which is a species of sob long continued ; and its slow sound is heard both in expiration and inspiration : Its expression consists in the continuation of a plaintive tone formed by inarticulate sounds. Groans are shorter or longer according to the degree of sorrow or dejection ; but they are generally repeated several times. The time of inspiration forms the interval that takes place between each groan ;

and

and the intervals are nearly equal both in their duration and their distance. The plaintive shriek is a groan expressed with force, and with a high tone of voice. The shriek, when very sharp, generally continues on the same tone through its whole extent ; but, when moderate, it commonly ends in a lower tone.

Laughter is an interrupted sound, often repeated, and accompanied with a kind of convulsive motion of the belly, which is alternately elevated and depressed. To facilitate this motion, the breast and head are sometimes thrown forward ; the chest remains immoveable ; the angles of the mouth recede from each other ; and the cheeks swell : Every time that the belly is depressed, the air bursts from the mouth, and occasions a noise, which, during the fit, is often repeated, sometimes on the same tone, and sometimes the tones gradually diminish.

The lips, in immoderate laughter, and in most violent passions, open wide ; but, in the more tranquil emotions, the angles of the mouth recede, without any opening of the lips, the cheeks swell, and, in some persons, dimples are formed in them near the corners of the mouth : This charm belongs to the graces, and is commonly attended with an agreeable smile, which is a mark of benevolence, and of internal satisfaction : A smile is also a mode of expressing contempt and ridicule ; but, in these malignant smiles, we press the lips close to each other.

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The cheeks are uniform features, and have little motion or expression, except from that involuntary redness or paleness with which they are covered in different passions ; they unite the features, and give a contour to the face ; they contribute more to beauty than to expression ; and the same observation may be applied to the chin, the ears, and the temples.

Shame, anger, pride, joy, equally give rise to blushing ; while fear, terror, and sorrow, produce a paleness in the face. This change of colour is involuntary ; it exhibits the state of the mind without its consent. It is an effect of sentiment over which the will has no command. We can easily disguise the other marks of passion ; for a moment's reflection enables us to stop the action of the muscles of the face which characterise particular passions, and even to change their direction ; but to stop or alter the redness or paleness of the countenance, is beyond our power ; because these depend on a peculiar motion of the blood, occasioned by the action of the diaphragm, which is the chief internal organ of sensation.

In different passions, the whole head is affected with different motions and positions : It hangs forward during shame, humility, and sorrow ; it inclines to one side in languor and compassion ; it is elevated in pride, erect and fixed in obstinacy and self conceit ; it is thrown backward in astonishment or surprise ; and rolls from side

side to side in contempt, ridicule, and indignation.

Grief, joy, love, shame, and compassion, make the eyes swell, and cause the tears to flow. The effusion of tears is always accompanied with a contraction of the muscles of the face, which opens the mouth ; the tears flow through the lachrymal ducts into the nose, and increase the fluid with which it is naturally moistened : The flowing of the tears is not constant ; they seem to burst out at irregular intervals.

In grief, the corners of the mouth are depressed, the under-lip rises, the eye-lids fall down, the pupil is elevated, and half concealed under the eye-lid : The other muscles of the face are relaxed, which enlarges the space between the mouth and the eyes ; and, of course, the countenance appears to be stretched out beyond its ordinary length. (See plate X. fig. 1.)

In consternation and terror, the brow is wrinkled, the eye-brows are elevated, the upper eye-lid opens so wide that it rises above the pupil, and uncovers a part of the white above the pupil, which last falls down, and is partly concealed by the under-lid. The mouth, at the same time, opens wide, the lips recede from each other, and expose the teeth both above and below. (See plate X. fig 2.)

In contempt and derision, one corner of the upper-lip rises, and leaves the teeth bare ; the other corner moves a little, and has the appearance of a malignant smile ; the nostril next the elevated side of the lip shrivels up, and the angle of the mouth falls down. The eye on the same side is almost shut, while the other remains open ; and both pupils are depressed in the same manner as when a person looks down from a height. (See plate X. fig. 3.)

In jealousy, envy, and malice, the eye-brows fall down and are wrinkled ; the eye-lids rise, and the pupils fall down ; the upper lip is elevated on both sides ; the angles of the mouth sink a little, and the middle of the under-lip rises and joins the middle of the upper one. (See plate X. fig. 4.)

In laughing, the angles of the mouth are drawn back, and somewhat elevated ; the upper part of the cheeks rise ; the eyes are more or less shut ; the upper lip rises and the under one sinks ; the mouth opens ; and, when the laughter is immoderate, the skin of the nose wrinkles. (See plate X. fig. 5.)

Beside these marks, the arms, the hands, and the whole body, contribute to the expression of the passions. Gesture also concurs with the action of the features in expressing the different emotions of the soul. In joy, for example, the eyes, the head, the arms, and whole body, are agitated with quick and various movements. In

Langour and grief, the eyes are sunk, the head reclines, the arms hang down, and the whole body remains fixed and immoveable. In admiration, surprise, and astonishment, every motion is suspended, and the person remains in the same uniform attitude. These expressions of the passions are involuntary: But there is another species of expression, which consists in an agitation of the eyes, head, arms, and body; and these motions seem, at the same time, to be the effect of reflection, and to depend on the will. They appear to be efforts of the mind to defend the body, and may be regarded as secondary symptoms, by which particular passions may be distinguished. In love, hope, and keen desire, we elevate the head, and turn towards heaven, as if imploring possession; we stretch forward the head to make a nearer approach; and we extend the arms and open the hands, in order to seize and embrace the beloved object. On the other hand, in fear, hatred, and horror, we push the arms forward with precipitation, to repel the object of our aversion; we turn back the head and the eyes; we recoil, and at last fly, in order to avoid it. These motions are so sudden, that they appear to be involuntary: But this deception is the effect of habit; for these motions are produced by reflection, and, by their alacrity, discover the perfection of those qualities of the body which enable it to obey, with such amazing promptitude, the commands of the mind.

As

Plate X

Fig. 1



Fig. 2



Fig. 3



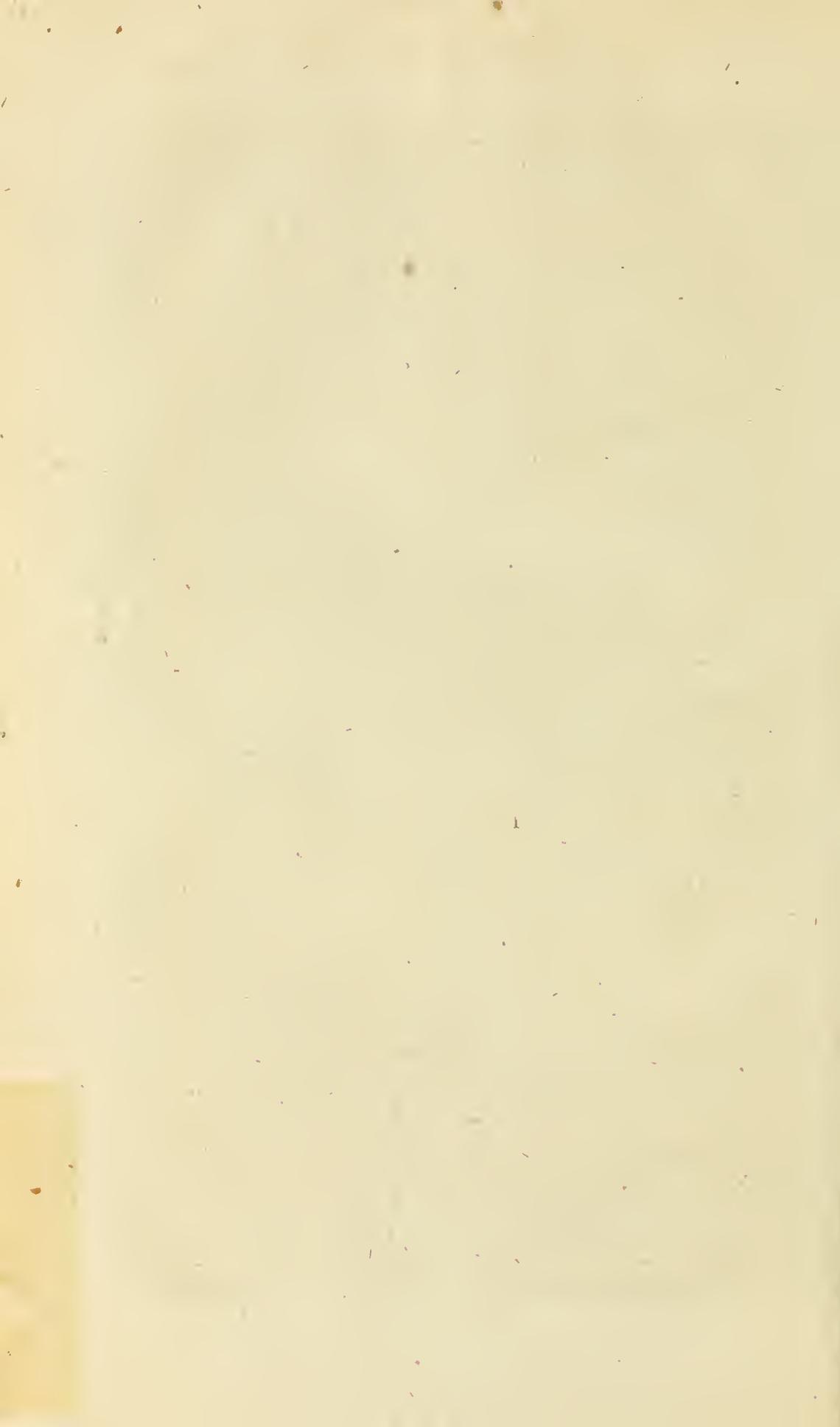
Fig. 5



Fig. 4



A Bell. Sculp!



As the passions are agitations or movements of the mind, for the most part connected with impressions of sensation, they may be expressed by motions of the body, and particularly by those of the countenance. We can, therefore, form a judgment of the affections of the mind by the motions of the body, and can discover the real situation of the soul by examining the changes in the features of the face. But, as the mind has no figure which can have any relation to that of matter, we can form no judgment of the general disposition of any mind by the features of the countenance, or by the figure of the body with which it is connected. A deformed body may contain an amiable mind; neither should we pronounce concerning the natural disposition of any person, merely because the features of his countenance are not agreeable; for there is no analogy between features and the nature of the soul, upon which any reasonable conjectures can be founded.

The ancients, however, were much addicted to this false notion; and there have not been wanting in every age, men who wished to support a scientific divination derived by a pretended skill in physiognomy. But nothing is more evident, than that this species of divination can be extended no farther than to the affections of the mind, when expressed by the motion of the eyes, visage, and other parts of the body: The form of the nose, of the mouth,

and of other features, has no more connection with the natural disposition of any person, than the stature, or size of the limbs, with the faculty of thinking. Has a man more genius in proportion as his nose is well made? Is the ability of another more circumscribed, because his eyes are small and his mouth large? It must, therefore, be acknowledged, that the divination of physiognomists is altogether chimerical, and destitute of any foundation in nature.

The ears, of all the parts of the head, contribute least to the expression of the face. They are placed at a side, and commonly concealed under the hair. But, in quadrupeds, the ears are more apparent; and by them we can discover whether the creatures be in a state of vigour or of imbecility; their motions denote sentiment, and correspond to the internal feelings of the animal. The human ears, though furnished with muscles, have hardly any motion, either voluntary or involuntary. Small ears are said to be most beautiful; but large ones are better calculated for hearing. Some nations greatly enlarge the lobs of their ears, by piercing them, and placing in them pieces of wood or metal, which they change successively for others of greater dimensions, till the holes become enormous; and the lobes uniformly increase in proportion to the size of the holes. I have seen these round pieces of wood, which had been brought from India or south America, of more than an inch and

and a half in diameter. It is difficult to investigate the origin of this singular custom; but it is equally difficult to trace the origin of piercing the ears, (a practice almost general), and sometimes the nostrils, in order to adorn them with rings, &c. unless we attribute it to those naked savages, who contrived to carry, in the least incommodious manner, such things as appeared to them to be most precious.

But the whimsical varieties in the customs of different nations are still more apparent in the manner of dressing and wearing their beards. The Turks shave their heads; but allow their beards to grow. Most Europeans, on the contrary, shave their beards, and wear their own or borrowed hair. The savages of America pull out the hairs of their beards, but carefully preserve those of the head. The Negroes shave their heads in different figures; sometimes they cut their hair in the shape of little stars, sometimes in the manner of a friar, but most commonly in alternate stripes. The Talapoins of Siam shave the heads and eye-brows of those children whose education is entrusted to them. In this article every nation has different usages. Some prefer the hair on the upper lip to that of the chin; others esteem hair on the cheek; some curl it, and others wear it straight. It is not long since we wore our hair behind loose and floating; we now inclose it in a bag. Our dress is different from that of our fathers. The differences in

dress is as various as the different nations of the globe: And, what is singular, we have adopted that dress which is most incommodiōus, wastes most time in adjusting, and is least agreeable to Nature.

Though fashions seem to be founded on caprice and fancy; yet, when generally adopted, they merit examination. Men have always given a value to those things which excite attention, and which convey flattering ideas of riches, power, and grandeur. The value of diamonds, and other precious stones, arises from their scarceness and brilliancy. The same observation applies to those shining metals, the weight of which we regard so little, that, for the sake of finery, we spread them over our garments. Ornaments of this kind are intended to excite the attention of spectators, to give them an idea of splendour and wealth, and to dazzle their fancies: How few have the capacity of distinguishing the person from the dress, or of estimating the man in any other manner than by the metal on his clothes?

Every thing that is rare and brilliant will, therefore, always be fashionable, while men derive more eminence from riches than virtue, and while the means of acquiring respect continue so widely different from real merit. Strangers receive their first impressions of us from our dress, which is varied according to the points of view in which we wish to be considered. The

modest

inodest man, or he who wishes to assume that character, dresses with a simplicity corresponding to the nature of that virtue. The vain-glorious, on the contrary, neglect nothing that can support their pride or flatter their vanity; and they distinguish themselves by splendour or fineness in their external appearance.

Another very general object of dress is to increase the size of our figure, and to occupy more room in the world than Nature has allotted to us. We wish to enlarge our dimensions by high-heeled shoes and blown up garments; but, however bulky our dress, it is exceeded by that vanity which it endeavours to cover. Why is the doctor's head loaded with an enormous quantity of borrowed hair, while that of the beau is so thinly covered? The former wishes to have the extent of his learning measured by the apparent dimensions of his head; and the latter desires to diminish his head, that he may exhibit the gaiety and sprightliness of his genius.

Other fashions appear to have a more rational object, namely, to conceal the defects of Nature, or to render them less disagreeable. Taking mankind in general, there is a greater number of deformed bodies, and disagreeable faces, than of handsome figures, and beautiful countenances. Fashions are always regulated by the practice of the majority; and, as the greatest part of mankind have defects to conceal, it is their interest to invent and support those modes which

which tend to render their deformities less conspicuous. Women never think of paint, till the natural bloom of their cheeks is faded. Painting, however, is a very general custom. The mode of whitening the hair * with powder, and curling it, is not so universal ; but it seems to have been intended for the same purpose, to make the colours and features of the countenance appear with greater advantage.

But, leaving external ornaments, and the drapery of the picture, let us return to the figure itself. The head of man is differently constructed, both internally and externally, from that of any other animal. The head of the monkey makes the nearest approach ; its brain, however, is proportionally less ; and there are other differences, to be afterwards pointed out. The bodies of almost all quadrupeds are entirely covered with hair. In man, the head alone has this ornament before the age of puberty, and it is more amply furnished with hair than the head of any other animal. The monkey resembles man very much in his ears, nose, and teeth.

Among animals, there is a great diversity in the size, position, and number of their teeth. Some are furnished with teeth in both jaws ; others have them in the under-jaw only ; in some they are widely separated from each other ; and

* The savages of New Guinea powder their heads and beards with chalk. See Recueil des Voyages, &c. tom. 4. p. 637.

and are close and united in others. The palate of some fishes is a hard bony plate, stuck full of sharp points, which perform the office of teeth.

The mouths of most animals are armed with some solid substance, which enables them to apprehend or grind their food. The teeth of men, quadrupeds, and fishes, the beaks of birds, the pinchers, saws, &c. of insects, are all hard instruments, and, like the nails, horns, and hoofs, derive their origin from the nerves. We formerly remarked, that nerves, when exposed to the air, acquire a surprising hardness. As the mouth gives a free access to the air, it is therefore natural to think that the nerves which terminate there should harden, and produce the teeth, the bony plate, the beak, the pinchers, and all the other solid parts of animals.

The neck supports the head, and unites it to the body. It is larger and stronger in most quadrupeds than in man. Fishes, and other animals which are not furnished with lungs similar to ours, have no neck. Birds, in general, have longer necks than other animals. Those birds which have short claws have likewise short necks, and *vice versa*. Aristotle says, that birds of prey which have pounces are all short necked.

The human breast is proportionally larger than that of other animals; and none but man and the monkey have collar-bones. The breasts of women are larger and more prominent

nent than those of men: But their consistence and structure are nearly the same; for the breasts of men can secrete milk. There are many examples of this fact; and it commonly happens at the age of puberty. I have seen a young man of fifteen years squeeze more than a spoonful of milk out of one breast. Among animals there is a great variety in the number and situation of their paps. Some, as the monkey and elephant, have only two placed on the fore part of the breast; others have four, as the bear; others, as the sheep, have only two situated between the hinder legs; others have them in great numbers upon the belly, as the bitch and the sow. Birds, and all the oviparous animals, have no paps. Viviparous fishes, as the whale, the dolphin, &c. have breasts, and suckle their young. The form of the breasts varies in different animals, and even in the same animal at different ages. It is alledged, that women, whose breasts are shaped like a pear, make the best nurses, because the mouth of the child comprehends not only the nipple, but part of the breast itself.

Below the breast is the belly, in which the navel makes a conspicuous figure. In other animals it is hardly perceptible; and even the monkey has nothing in place of it but a kind of callosity.

The arms of man have little resemblance to the fore feet of quadrupeds, and still less to the

the wings of birds. The monkey tribe are the only animals which have arms and hands ; but their structure is more rude, and their proportion less exact than those of man ; his shoulders are likewise larger, and differently constructed from those of any other animal ; and it is on the top of the shoulders that he can bear the heaviest burdens.

The form of the back differs not much from that of some quadrupeds ; the region of the reins is indeed more muscular and strong. But the buttocks are peculiar to the human body ; the thighs of quadrupeds are often mistaken for the buttocks, though they be totally different. Man being the only animal who can support himself perfectly erect, the swelling, or cushion on the top of his thighs, is necessary to sustain him in that posture.

The human foot is very different from that of all other animals, the monkey not excepted. The foot of the ape is rather a kind of hand ; its toes are long, and situated like fingers, the middle one being by much the longest ; and it has no heel. The sole of the foot is likewise larger in man, and his toes are better adapted for preserving the equilibrium of the body in walking, running, dancing, and other movements.

The human nails are less than those of other animals. If they protruded much beyond the points of the fingers, they would obstruct the dexterity of the hand. Those savages who al-

low them to grow to an unnatural length, use them for flaying and tearing animals. But, although their nails be stronger and longer than ours, they can by no means be compared to the hoofs or claws of other animals.

With regard to the proportions of the human body, we have no exact knowledge. The same parts have not the same proportions in any two individuals ; and, even in the same person, the corresponding parts are not perfectly similar. For example, the right arm or leg have seldom the same dimensions with the left. Repeated observations alone can ascertain a standard by which we may be enabled to form a perfect idea of the natural and best proportions of the human figure. It is not by comparing men, or taking their dimensions, that we are to expect any light upon this subject : We have more to hope from the art of designing, and the efforts which have been made in imitating Nature. Taste and sentiment have exceeded the limits of mechanical operations. The square and compass are laid aside, and we trust more to the impressions made on the senses. Every possible form has been realized in bronze or in marble. We recognise the standard of Nature more by imitating her, than by her own productions ; and we judge better concerning the perfection of a statue by viewing it, than by taking its different dimensions. It is by long practice in the art of designing, and by delicacy

cacy of sentiment, that eminent statuaries have been enabled to make men feel the justness of proportion in the works of Nature. The ancients made statues so exquisitely fine, that they have uniformly been regarded as exact representations of the most perfect human figures. These statues, which were only copies of the human form, are now considered as originals ; because they were not imitated from an individual, but from the whole species, so attentively compared and diligently observed, that it is impossible to find an equal degree of symmetry and proportion in any one man that ever existed. We shall, therefore, relate the dimensions of the different parts which these artists have fixed as standards of perfection. They commonly divide the height of the body into ten times the length of the face ; they likewise divide each *face*, or tenth of the body, into three equal parts ; the first commences at the springing of the hair on the forehead, and terminates at the root of the nose ; the nose is the second division ; and the third extends from the nose to the end of the chin. In measuring the rest of the body, they use the term *nose*, or length of the nose, to denote the third of a face, or the thirtieth part of the body. The first face begins at the root of the hair above the forehead, and extends to the end of the chin ; but, from the top of the forehead to the crown, there is still a third of a face, or a nose, in height. Thus,

from

from the top of the head to the end of the chin, there is a face and a third ; from the chin to the juncture of the clavicles, two thirds of a face ; and, therefore, from the top of the breast to the crown of the head, is twice the length of the face, or the fifth of the body ; from the joining of the clavicles to the under part of the paps, they reckon one face ; from this to the navel is a fourth face ; and the fifth extends from the navel to the division of the inferior extremities, which should complete half the length of the body. Two faces are exhausted between the thigh and knee, to the last of which they allow half a face, being the first half of the eighth face ; two faces are assigned between the knee and top of the foot, and from that to the sole half a face, which completes the ten faces, or length of the body. This division has been made from men of ordinary size ; but, in those of a higher stature, they allow about half a face additional between the paps and the commencement of the thighs, which, in tall men, is not the middle of the body. When the arms are fully stretched in a horizontal line, the space between the tops of the middle fingers is equal to the length of the body. From the joining of the collar-bone to the articulation of the shoulder-bone with that of the arm, is one face. When the arm hangs down, or is bended forward, it is four faces in length ; two between the joint of the shoulder and the elbow, and

two between the elbow and the root of the little finger, in all five faces, and an equal number for the other arm, which is precisely the length of the body; about half a face remains for the length of the fingers; but it must be remarked, that half a face is lost in the joints of the elbows and shoulders, when the arms are extended. The hand is about a face in length, the thumb a third of a face, or a nose, and the longest toe is of the same length with the thumb. The under part of the foot is equal in length to the sixth part of the height of the body. For the reasons already mentioned, if an experiment be made of these dimensions upon any individual, they will appear to be extremely imperfect. It is still more difficult to fix the proportional thickness of the different parts of the body. The changes are so great when the same man is meagre or in good case, and the action of the muscles in different positions, creates so much variety in the dimensions of the parts, that it is almost impossible to give any determined rules upon this subject.

The superior parts of the body, in infancy, are larger than the inferior; the thighs and legs are not nearly equal to half the length of the whole body; as the child advances in years, the inferior parts grow more in proportion than the superior; and, when the growth is complete, the thighs and legs are very nearly one half the length of the body.

The

The anterior parts of the chest, in women, is more elevated, and its diameter larger, than in men; but the chests of the latter are proportionally broader. The haunches of women are likewise larger than those of men; because the haunch-bones of women, and those which join them and compose the pelvis, are proportionally larger. These differences in the structure of the chest and pelvis are so perceptible, that it is easy, by this criterion, to distinguish the skeleton of a woman from that of a man.

There are great varieties in the length of men. Those are said to be tall who are from five feet eight inches to six feet high. The middle stature is from five feet five to five feet eight; and those who fall below these dimensions are said to be of small stature. Women, in general, are two or three inches below the standard of men. Of giants and dwarfs, notice shall be taken in another place.

Though the human body be externally more delicate, it is, however, very nervous, and perhaps stronger, for its size, than the most robust quadruped. In comparing the force of a lion to that of a man, it ought to be considered, that the lion is armed with teeth and talons; and that these dreadful weapons convey a false idea of real strength. The arms which man has received from Nature are not offensive; and happy had it been if art had never put into his hands

hands weapons more destructive than the claws of the lion.

But there is a juster method of instituting a comparison between the strength of a man and that of the other animals, namely, by the weight they are able to carry. It is affirmed, that the porters of Constantinople can carry burdens of nine hundred pounds weight ; and Desaguliers tells us, that, by means of a certain harness, by which every part of a man's body was proportionably loaded, the person he employed in this experiment was able to support, in an erect posture, a weight not less than 2000 pounds. A horse, which is about six times the size of an ordinary man, ought, therefore, when managed in the same manner, to bear 12,000 or 14,000 pounds ; an enormous weight, in comparison of what that animal can support, even when it is distributed with every possible advantage.

The strength of animals may likewise be estimated by agility and perseverance in labour. Men, when accustomed to running, outstrip horses, or at least continue their speed much longer ; and a man will accomplish a long journey sooner, and be less fatigued, than even the best road horses. The royal messengers of Ispahan, who are trained to running, go 36 leagues in 14 or 15 hours. We are assured by travellers, that the Hottentots outrun lions in the chace ; and that those savages who live upon hunting, pursue and even catch deer, and other animals of

equal swiftness. Many other stories are told of the amazing nimbleness of savages, of the long journeys they accomplish on foot, over the most craggy mountains, where there is no path to direct, and every obstacle to obstruct their progress. These people are said to travel 1000 leagues in six weeks, or at most two months. If we except birds, whose muscles are proportionally stronger than those of any other animal, no other creature could support such long continued fatigue. The civilized man is ignorant of his own strength; nor is he sensible how much he is weakened by effeminacy, nor to what extent he might recover his native force by an habitual and vigorous exercise of his powers.

Men of extraordinary strength sometimes appear *. But this gift of nature, which would be highly valuable in the savage state, is of little use among polished nations, where more depends on mental than corporeal powers, and where manual labour is confined to the inferior orders of men.

Men are much stronger than women; and they have too often employed this superiority in exercising a cruel and tyrannical dominion over the weaker sex, who were entitled to share with them both the pleasures and the pains of life. Savage nations condemn the women to perpetual

* Nos quoque vidimus Athanatum nomine prodigiae ostentationis quingenario thorace plumbeo indutum, cothurnisque quingentorum pondo calcatum, per scenam ingredi. Plin. lib. 7.

tual labour. They cultivate the ground, and perform every office of drudgery, while the men indolently recline in their hammocks, from which they never think of stirring, unless when they go a hunting or fishing ; and, so averse are they to motion, that they have often been known to stand in the same position for several hours. A savage has no idea of walking for amusement ; and nothing astonishes him more than to see Europeans walking backwards and forwards in quest of nothing. All men are naturally indolent ; but the savages of warm countries are not only the most lazy of human beings, but the most tyrannical to their women, whom they treat with a cruel barbarity. In nations more civilized, men dictate laws to the women. These laws are always more severe in proportion to the grossness of the national manners ; and it is only among people highly polished that women have obtained that equality of condition which is due to them, and which contributes so powerfully to the happiness of society. This politeness of manners is the genuine offspring of the softer sex ; they have opposed it to the arms of the victor, while their modesty has taught us to acknowledge the empire of beauty, a natural advantage greatly superior to mere strength. But, to give it full force and value, requires the assistance of art ; for the ideas of beauty are so different, so capricious, and even contradictory, that the women, it is probable, have gained more

by the art of making themselves amiable, than by beauty itself, of which men form such opposite judgments. Men are agreed as to the ultimate object of their passion for the other sex, the estimation of which is augmented by the difficulty of acquisition. The beauty of women commenced the moment they learned to make themselves respectable, by refusing all approaches to their hearts which proceeded not from delicacy of sentiment; and, whenever the influence of sentiment was felt, polished manners was a necessary consequence.

The taste of beauty, among the ancients, differed widely from ours. With them, a small fore-head and joined eye-brows were charming features in a female countenance; and, in Persia, large joined eye-brows are still highly esteemed. In some Indian countries, black teeth and white hair are necessary ingredients in the character of a beauty; and in the Marian Islands it is a capital object with ladies to blacken their teeth with herbs, and to bleach their hair with certain liquors. Beauty, in China and Japan, is composed of a large countenance, small and half concealed eyes, a broad nose, minute feet, and a prominent belly. Some Indians of America and of Asia compress the heads of their children between two wooden planks, with a view to enlarge and beautify the face; others compress them laterally, others depress the crown only, and others make the head as round as possible

sible. Every nation has ideas of beauty peculiar to itself; and every individual has his own notions and taste concerning that quality. These peculiarities probably originate from the first agreeable impressions we receive of certain objects; and therefore depend more upon chance and habit than upon difference of constitution. When we come to treat of the senses, we shall perhaps be able to give more determined ideas concerning those perceptions of beauty we receive by the eye.

G g 3

S E C T.

Of Old Age and Death.

EVERY object in Nature must change and decay. The bodies of men no sooner arrive at full maturity, than they instantly begin to decline. The waste is at first insensible; several years frequently revolve before we perceive any considerable alteration. But we ought to feel the weight of our years, better than their number can be estimated by strangers; and, as those are seldom deceived who judge of our age by external characters, we would be still more sensible of it from what passes within us, if we were more attentive to our feelings, and deceived not ourselves by vanity and fallacious hopes.

When the body has acquired its full length, it increases in thickness: The commencement of this augmentation is the first step towards decay; for this extension is not a continuation of growth, which would communicate force and activity, but merely an addition of superfluous matter, that blows up the body, and loads it with a useless weight. This matter, which

which is denominated fat, generally appears at the age of 35 or 40 years; and, in proportion as the quantity of it augments, the body loses its former lightness and freedom of motion; its generative faculty is diminished; its members turn unwieldy; and it acquires extension at the expence of strength and activity.

Besides, the bones increase in solidity; the nutritious juices, which formerly served to expand the bones, now increase their quantity of matter only, by filling up their internal cavities; the membranes are changed into cartilages, and the cartilages into bones; the fibres of the muscles grow rigid; the skin is deprived of its moisture, and wrinkles are gradually formed in it; the hair turns hoary; the teeth fall out; the visage assumes a haggard appearance, the body bends forward, &c. The first approaches of this state are perceptible before the age of 40; they advance by slow degrees till 60, and more rapidly from that to 70, when decrepitude commences, and continues to augment till 90 or 100, when death puts a final period to our existence.

We shall now take a more particular survey of these changes; and, as we have inquired into the causes of the growth and expansion of the human body, let us also investigate those of its decay and dissolution. At the commencement of our existence, the bones are only small fibres, of a soft and ductile substance, and gradually acquire consistency and solidity. They may be

considered

considered, in their original state, as small tubes lined, both within and without, with a thin membrane: This double membrane furnishes the osseous matter; for the small interval between the internal and external periosteum is soon converted into a bony plate. Some idea of the production and growth of bones may be formed, by comparing them with the manner in which wood and the more solid parts of vegetables are produced. We shall take, for example, the fig-tree or the alder, which are at first hollow in the middle, like the thigh and other hollow bones of the body. When a bud, that is to form a branch, begins to extend, it is only a soft ductile matter, which, by extension, becomes a slender herbaceous tube filled with pith: The external and internal surfaces of this tube are covered with a fibrous membrane, as well as the internal partitions by which the cavity is divided. These membranes, however thin, are composed of several plates of fibres lying above each other, which are still soft, but gradually harden by depositing the sap which they absorb for their nourishment; and by this means a woody plate is formed, during the first year, between the two membranes, which is more or less thick in proportion to the quantity of sap that has been deposited between the external and internal membranes. But, though each of these membranes become woody internally, their external surfaces remain soft and

and ductile ; and, the following year, when the bud at the top of the branch begins to expand, the sap rises through the soft fibres of each membrane, and converts them, by its sediments, into other woody plates. The same process goes on annually ; and, in this manner, the tree or branch gradually increases in thickness. The internal cavity likewise augments in proportion to the growth of the branch ; because the internal membrane extends along with the other parts, and the woody plates are only applied successively to the plates already formed. If we examine a branch, or a joint, which has been the product of one year, we shall find, that it uniformly preserves the same figure through all the stages of its growth. The joints or knots which mark the production of each year, become fixed points for the reaction of those powers that expand the contiguous parts during the following year. The superior buds react against these points, and, by expanding themselves, form new branches or joints in the same manner as the first were produced.

The process of ossification would be very similar to that we have now described, if the fixed points of the bones began at the extremities, in place of the middle. At first the bones of the foetus are only small threads, or tubes, of a ductile matter, which are easily perceived through the delicate and transparent skin. The thigh-bone, for example, is then a small short tube,

like

like the herbaceous tubes above described. This tube is shut at both ends by a pulpy substance, and its external and internal surfaces are covered with two membranes composed of several layers of soft and ductile fibres. In proportion as this tube receives nutritious juices, the two extremities extend and recede from the middle point, which always preserves the same station. The extremities cannot extend without reacting against this middle point ; and the parts which are nearest it begin first to acquire solidity. The first bony plate, like the first plate of wood, is produced in the interval which separates the two membranes or periosteum. But the ossification commences in the middle, and gradually extends to the extremities, which remain soft long after the middle parts are converted into bone. The middle parts of bones, therefore, being first ossified, it is impossible that they should afterwards expand equally with those parts which remain longer in a soft and ductile state. This is the reason why bones are always thinnest in the middle, and thickest at the extremities. But, independent of this difference between the longitudinal growth of bones and of wood, the analogy between their increase in thickness is very striking : For the first bony plate is produced from the internal part of the periosteum ; and, after the formation of this plate between the two periosteum, two other plates are soon formed, one on each side of the first,

to which they adhere ; and, by this means, both the circumference of the bone, and the diameter of its cavity, are augmented. Thus the interior parts of the two periosteal continue successively to produce bony plates, in the same manner as woody plates are produced from the bark of vegetables.

But, after the bone has acquired its full growth, after the periosteal cease to furnish osseous matter, then the nutritious juices, which were formerly employed in augmenting the bulk of the bone, serve only to increase its density. These juices are deposited in the internal parts of the bones, and give them more weight and solidity, as may easily be perceived by comparing the weight and density of an ox with those of a calf. The substance of the bones become, in process of time, so compact, as not to admit the circulation of those juices which are necessary for their support and nourishment. This substance, therefore, must now undergo a change similar to that which takes place in old trees, after they have acquired their full solidity ; and this change is one of the first causes which render the dissolution of the human body inevitable.

The cartilages, which may be regarded as soft and imperfect bones, likewise receive nutritious juices, which gradually augment their density. They become more and more solid as we advance in years ; and, in old age, they are almost

as

as hard as bones. This rigidity of the cartilages renders the motion of the joints extremely difficult, and, at last, deprives us of the use of our members, and produces a total cessation of external movements. This is a second, and more marked cause of death, because it manifests itself by a laborious performance of the common actions of the body.

The membranes likewise become hard and dry, as we advance in years. Those, for example, which surround the bones, soon lose their flexibility. At the age of 20, they are incapable of farther extension. The muscular fibres suffer a similar change, in proportion to the time of life; though, to the touch, they seem to be softer as age increases. It is not the muscles, however, but the skin, that occasions this perception. After the body is come to its full growth, the fat increases, and, by being interposed between the fibres of the muscles, and between the skin and the muscles themselves, makes them feel softer, when, in reality, their density is greatly increased. Of this fact we have an incontestible proof, by comparing the flesh of young with that of old animals. In the former, it is tender and delicate; but, in the latter, it is dry, hard, and unfit for eating.

The skin always extends as the body increases; but, when the body diminishes, the skin has not elasticity enough to enable it to contract to its former dimensions: It, therefore, continues in wrinkles

wrinkles and folds, which can never be effaced. The wrinkles of the face partly arise from this cause; but, in their production, they have a relation to the form, to the features, and to the habitual motions of the countenance. If we examine the face of a man of 25 or 30 years of age, we may trace the origin of all the wrinkles which will appear in old age, especially when he laughs, cries, or makes any violent grimace. All the folds which are exhibited in these actions will in time become indelible wrinkles.

In proportion as we advance in years, the bones, the cartilages, the membranes, the flesh, the skin, and every fibre of the body, become more solid, hard, and dry. Every part shrinks and contracts; and every movement is performed with slowness and difficulty: The circulation of the fluids is sluggish and interrupted; perspiration is diminished; the secretions change; digestion becomes slow and laborious; the nutritious juices are less abundant, and, being rejected by parts which are already too dense, they communicate no supplies. These parts, therefore, may be regarded as already dead, because they have ceased to receive nourishment. Thus the body dies by inches; its motions gradually decay; life wears away by imperceptible degrees; and death is only the last term in the series.

As, in women, the bones, the cartilages, the muscles, and every other part of the body, are softer

softer and less solid than those of men, they must require more time in hardening to that degree which occasions death: Women, of course, ought to live longer than men. This reasoning is confirmed by experience; for, by consulting the bills of mortality, it appears, that, after women have passed a certain age, they live much longer than men who have arrived at the same age.

From what has been said, it may also be concluded, that men who have a weakly appearance, and approach nearer to the constitution of women, should live longer than those who are more robust; and likewise, that persons of either sex, who are long before they arrive at their full growth, should outlive those who advance more rapidly to that point; because, in this case, the bones, cartilages, and fibres, are later in arriving at that degree of solidity which is necessary to their destruction.

This natural cause of death is common to all animals, and even to vegetables. An oak perishes only because the oldest parts of the wood, which are in the centre, become so hard and compact, that they can receive no further nourishment. The moisture they contain being deprived of circulation, and not being replaced by fresh supplies, ferments, corrupts, and gradually reduces the fibres of the wood into powder.

The duration of life may, in some measure, be computed by the time occupied in growth. A plant or an animal that acquires maturity in

a short time, perishes much sooner than those which are longer in arriving at that period. In animals, as well as vegetables, the longitudinal growth is first finished. Man grows in stature till he be 16 or 18 years of age ; but his body is not completely unfolded in thickness before that of 30. Dogs acquire their full length in less than one year ; but their growth in thickness is not finished till the second year. A man, who grows 30 years, lives till 90 or 100 ; and a dog, whose growth terminates in two or three years, lives only 10 or 12. The same observation may be applied to most animals. Fishes continue to grow for a great number of years ; they accordingly live for centuries ; because their bones never acquire the density of those of other animals. When we give the particular history of animals, we shall examine whether there be any exception to this rule, which Nature seems to follow in proportioning the duration of life to the time of growth, and whether crows and stags live so long as is commonly imagined. But it may be laid down as a general fact, that large animals live much longer than small animals, because they require more time to finish their growth.

Thus the causes of our dissolution are inevitable ; and it is equally impossible to retard that fatal period, as to change the established laws of Nature. The ideas of those visionaries, who conceived the possibility of perpetuating human life

life by the use of certain medicines, would have perished with themselves, if self-love did not always induce us to believe what exceeds the powers of Nature, and to be sceptical with regard to the most certain and invariable truths. The universal panacea, the transfusion of the blood, and other methods which have been proposed to render our bodies immortal, are as chimerical as the fountain of youth is fabulous.

When the constitution is sound, life may, perhaps, be prolonged for a few years, by moderating the passions, and by temperance. But even this is a difficult point; for, if it be necessary that the body should exert its whole force, and that it should waste all its powers by labour and exercise, what advantages can we derive from regimen and abstinence? Some men have indeed exceeded the ordinary term of human life: Without mentioning those extraordinary instances of longevity recorded in the Philosophical Transactions, such as that of Par who lived to the age of 144, and of Jenkins who lived 165 years, we have many examples of the prolongation of life to 110, and even 120. These men, however, used no peculiar arts for the preservation of their bodies. They appear, on the contrary, to have been peasants, huntsmen, labourers, and people accustomed to abuse their bodies, if it be possible to abuse them by any other means than those of continual idleness and debauchery.

Beside,

Besides, the varieties of climate, and of the modes of living, make no difference as to the period of our existence, which is the same in the European, the Negro, the Chinese, the American, the civilized man and the savage, the rich and the poor, the citizen and the peasant. Neither does the difference of races, of food, or of accommodation, make any change on the duration of life. Men who feed upon raw flesh or dried fish, on sago or rice, on cassada or roots, live as long as those who are nourished with bread and prepared viands. It is apparent, therefore, that the duration of life has no dependence either on manners or customs, or the qualities of particular food: If luxury and intemperance be excepted, nothing can alter those laws of mechanism which regulate the number of our years.

Any little differences which may be remarked in the term of human life seem to be owing to the quality of the air. There are generally more old men in high than in low countries. The mountains of Scotland, of Wales, of Auvergne, and of Switzerland, have furnished more examples of extreme old age than the plains of Holland, Flanders, Germany, or Poland. But, taking mankind in general, there is hardly any difference in the duration of life. When men are not cut off by accidental diseases, they every where live 90 or 100 years. Our ancestors never exceeded this period; and, since

the age of David, it has suffered no variation. If it should be asked, why the first races of men lived 900, 930, and even 969 years? we may, perhaps, be able to give a satisfactory answer. The productions of the earth were then of a different nature. The surface of the globe, as we remarked when treating of the Theory of the Earth, was, in the first ages of the world, less solid and compact; because, gravity having acted for a short time only, terrestrial bodies had not acquired their present density and consistence. The produce of the earth, therefore, must have been analogous to its condition. The surface being more loose and moist, its productions would, of course, be more ductile and capable of extension: Their growth, therefore, and even that of the human body, would require a longer time of being completed. The softness and ductility of the bones, muscles, &c. would probably remain for a longer period, because every species of food was more soft and succulent. Hence, the full expansion of the human body, or when it was capable of generating, must have required 120 or 130 years; and the duration of life would be in proportion to the time of growth, as is uniformly the case at present: For, if we suppose the age of puberty, among the first races of men, to have been 130 years, as they now arrive at that age in 14 years, the age of the Antedeluvians will be in exact proportion to that of the present race; since, by multiplying

multiplying these two numbers by seven, for example, the age of the present race will be 90, and that of the Antedeluvians will be 910. The period of man's existence, therefore, may have gradually diminished in proportion as the surface of the earth acquired more solidity by the constant action of gravity; and it is probable, that the period from the creation to the days of David, was sufficient to give the earth all the density it was capable of receiving from the influence of gravitation; and, consequently, that the surface of the earth has ever since remained in the same state, and that the terms of growth, in the productions of the earth, as well as in the duration of life, have been invariably fixed from that period.

Independent of accidental diseases, which are more frequent and dangerous in the latter periods of life, old men are subject to natural infirmities, that originate solely from the decay of the different parts of the body. The muscles lose their tone, the head shakes, the hands tremble, the legs totter, the sensibility of the nerves decreases, and every sense is blunted. But the incapacity for generating is the most characteristic infirmity of old age. This impotency may be ascribed to two causes; an alteration in the seminal fluid, and a want of tension in the external organs. The defect of tension is easily explained from the conformation of the organ itself, which is a spongy cavernous substance,

fitted to receive into its cavities a great quantity of blood, in order both to increase its size, and to render it more rigid. In youth, this organ is soft and flexible; and, of course, it is easily extended by the impulse of the blood. But, as we advance in years, like every other part of the body, it becomes more solid, and loses its flexibility. Hence, though the impulse of the blood were equal to what it was in youth, this impulse is unable to dilate an organ which has become too dense to admit blood in a quantity sufficient to produce an erection that will answer the purposes of generation.

With regard to the change, or rather sterility of the seminal fluid, it cannot be prolific unless when it contains organic particles transmitted from every part of the body; for we have already shown *, that the production of a small organized being, similar to its parent, cannot be effected without the union of the organic particles sent from all parts of the body. But, in very aged men, the parts have become too solid, and can neither receive, assimilate, nor transmit the nutritive and prolific particles. The bones and other solids, therefore, can neither produce nor transmit organic particles correspondent to their own natures; these particles must, of course, be wanting in the seminal fluids of old men; and this defect is sufficient to render them incapable of generating.

But,

* See above, ch. 2. 3. &c.

But, admitting the sterility of old men to be owing to a defect in the organic particles of their seminal fluids, this defect may still be supplied by a young woman *, which not unfrequently happens; for old men sometimes, though rarely, generate; and, when they do produce, they have a much smaller share in their children than young men. This is likewise one reason why young women, who are married to old, decrepit, and deformed men, often produce monsters, or children still more deformed than their fathers. But this is not a proper place for such discussions.

The greatest part of mankind die of the scurvy, the dropsy, or other diseases which seem to proceed from a vitiation of the blood and other fluids. Whatever influence the fluids may have in the animal oeconomy, they are only passive and divisible substances, and obey the impulses of the solids, which are the true organic active parts, and upon which the motion, the quality, and even the quantity of the fluids entirely depend. In old age, the cavities of the vessels contract, the muscles lose their tone, the secretory organs are obstructed; the blood, the lymph, and the other fluids, of course, grow viscid, extravasate, and produce all those diseases and symptoms which are usually ascribed to a vitiation of the humours. But the natural decay of the solids is the original cause of these maladies.

H h 3

Thoughts

* See above, ch. 10.

Though it be true, that the bad state of the fluids proceeds from a depravity in the organization of the solids; yet the effects resulting from a change in the fluids produce the most alarming symptoms, if they become stagnant, or if they be obstructed in their circulation by the contraction of the vessels; if, by the relaxation of the vessels, they extravasate, they must soon corrupt, and corrode the weaker parts of the solids. In this manner the causes of destruction perpetually multiply; our internal enemies grow more and more powerful, and at last put a period to our existence.

All the causes of decay which I have mentioned, act continually upon the human body, and gradually lead to its dissolution. Death, which appears so terrible to us, is the last term only in the series of evils. Life begins to decay long before it is entirely extinguished; and the changes are perhaps greater from youth till the beginning of our decay, than from decrepitude to death; for we ought here to consider life as a subject capable of augmentation and of diminution. When the foetus is first formed, the quantity of life is almost equal to nothing: It gradually extends and acquires consistence and force, in proportion to the growth and expansion of the body. On the other hand, when the body begins to decay, the quantity of life diminishes, till its final extinction. Thus life

both

both commences and terminates by imperceptible degrees.

Why then should we be afraid of death, if we have no reasonable apprehensions of its consequences? Why dread this single moment, which has been preceded by an infinity of others of the same order; since death is fully as natural as life, and both arrive in the same manner, without our being able to perceive their approach? If we inquire of physicians, and those who are accustomed to observe the actions and sentiments of the dying, we shall find, that, except in a few acute diseases, attended with agitations and convulsions, which exhibit only the appearances of pain, most men expire quietly, and without the smallest indication of uneasiness. Even when patients seem to be afflicted with the most dreadful agonies, they have no existence but in the imagination of the spectator: The truth of this has been repeatedly attested by many people who have recovered after the most violent commotions and convulsions, who, notwithstanding, were unable to recollect a single pang they had felt, or a single idea or sentiment that had passed during this seemingly distressful situation.

The greatest part of mankind, therefore, die without being sensible of the fatal stroke; and of those who preserve their senses to the last groan, there is not, perhaps, one who does not entertain some hope of recovery. Nature, for the happiness of man, has rendered this principle

ple much stronger than reason. Men never cease to flatter themselves with hopes of recovery, even though they might judge of their real condition from the example of others who had been afflicted with the same incurable disorders, from the tears of their friends, and from the countenances or desertion of their physicians. All these mortifying circumstances are only regarded as premature and ill-grounded fears; and hope never leaves us, till death shuts the scene.

A sick man tells you, that he feels the hand of death, that the king of terrors is just about to arrive, and that recovery is impossible: But if, from zeal or indiscretion, he is informed of his approaching dissolution, his countenance instantly changes, and he betrays all that uneasiness which naturally attends the first intimation of death. This man, it is evident, gives no credit to his own assertions. He may entertain some doubts concerning his situation; but his hopes are always superior to his fears: And, if he were not alarmed by that cruel parade of grief which too often imbibes the sick man's couch, he would never perceive the approach of his dissolution.

Death, therefore, is not that horrible object which we have fancied to ourselves. It is a spectre which terrifies us at a distance, but disappears when we approach it more closely. Our conceptions of it are founded on prejudice; and we regard it not only as the greatest of all misfortunes,

fortunes, but as accompanied with the most excruciating tortures. The pain, it is said, must be extreme when the soul separates from the body ; its duration may also be long, since time is measured by the celerity of ideas ; and one painful moment, by augmenting the rapidity of our ideas, may have the appearance of an age, when the train of ideas proceeds with their usual gentleness and tranquillity. This reasoning is such an abuse of philosophy, that, if it had no influence in increasing the miseries of human life, it merits nothing but silence and contempt. As such arguments, however, gain credit with weak minds, and render the aspect of death a thousand times more hideous than it really is, a refutation of them may be attended with utility.

When the soul is first united to the body, do we feel a joy that transports us ? No. This union is effected without our perception ; why, then should we be conscious of their dissolution ? What reason have we to believe that the separation of the soul and body is attended with extreme pain ? What cause should produce this pain ? Does it reside in the soul or in the body ? Pain of mind can only result from thought ; and pain of body is always proportioned to its strength or weakness. At the approach of natural death, the body is in its weakest state, and, of course, it can feel but very little, if any pain.

Let us now suppose a violent death: Can the sufferings of a man, for example, whose head is carried off by a cannon-ball, be more than instantaneous; Can the succession of his ideas, during this instant, be so rapid as to make the pain seem to continue for an hour, a day, or a century? We shall endeavour to discuss this point.

I acknowledge that the succession of our ideas is the only natural measure of time, and that we conceive it to be shorter or longer in proportion to the uniformity or irregularity of their motions. But, in this measure, there is a unit or fixed point, which is neither arbitrary nor indefinite, but is determined by Nature, and corresponds with the particular organization of individuals. Two ideas, which succeed each other, must necessarily be separated by an interval; one thought, however rapid, must require some portion of time before it can be followed by another. No succession can take place in an indivisible instant. The same remark is applicable to sentiment or feeling. A certain time must elapse in the transition from pain to pleasure, or from one painful sensation to another. This interval between our thoughts and sensations is the unit or fixed point formerly mentioned; and it can neither be extremely long nor extremely short, but must be nearly equal in its duration; because it depends on the nature of the mind and the organization of the body, the movements of which must have a determined degree of celerity. In the same individual,

vidual, therefore, there can be no succession of ideas so rapid, or so flow, as to produce that enormous difference in duration, by which a momentary pain is prolonged to that of an hour, a day, or a century.

A very acute pain, if continued for a certain time, uniformly brings on either fainting or death. Our organs, which are endowed only with a certain degree of force, cannot resist more than a certain quantity of pain. If the pain becomes excessive, the organs are unable to support it ; and, of course, they can transmit no intelligence of it to the mind, with which there is no correspondence but by the distinct action of these organs. In this case, the action of the organs is interrupted ; and, consequently, all internal sensation is at an end.

What I have already remarked is perhaps more than is sufficient to evince, that the instant of death is neither accompanied with extreme nor long-continued pain. But, in order to eradicate the fears of the most timid of mankind, we shall still add a few words upon this subject. Excessive pain extinguishes all reflection, though symptoms of it have sometimes appeared in the very moment of violent death. When Charles XII. received the blow which terminated, in an instant, both his enterprises and his existence, he clapped his hand upon his sword. This mortal pang, since it excluded not reflection, could not be excessive. He found himself attacked ; he

he considered that he ought to defend himself; it is evident, therefore, that he felt no greater pain than he would have suffered from an ordinary stroke. This action could not be the result of a mechanical impulse; for I have shewn, in the description of man, that the most precipitate movements of the passions depend upon reflection, and are nothing but habitual exertions of the mind.

I would not have dwelt so long upon this subject, if I had not been anxious to eradicate a prejudice so repugnant to the happiness of man. I have seen many victims sacrificed to this prejudice, especially among the female sex, who die daily through the terror of death. Such dreadful apprehensions seem peculiarly to affect those who, by nature or education, are endowed with superior sensibility; for the vulgar look forward to their dissolution, either with indifference, or, at least, without any degree of terror.

True philosophy views objects as they exist. Our internal feelings would uniformly accord with this philosophy, if they were not perverted by the illusions of imagination, and by the unfortunate habit of creating hypothetical phantoms of excessive pains, and of pleasures which exceed the limits of human nature. Objects are only terrible or ravishing at a distance; when we have the resolution or the wisdom to take a near inspection of them, every alarming and

and every alluring circumstance instantly disappear.

If this doctrine, concerning the gradual and generally insensible decay of the vital powers, required any farther support, no inconsiderable aid might be derived to it from the uncertainty of the signs of death. If we consult the writers on this subject, and particularly those of Winslow and Bruhier, we shall receive full conviction, that, between life and death, the shade is often so undistinguishable, as to elude all the powers of the medical art. They inform us, 'That the colour of the face, the heat of the body, the suppleness of the joints, are uncertain marks of life; and that the paleness of the countenance, the coldness of the body, the rigidity of the extremities, the cessation of motion, and the abolition of the senses, are very equivocal signs of death.' The same remark may be made with regard to the apparent cessation of the pulse, and of respiration: These motions are often so slow, that they elude all our perceptions. A mirror or a candle is applied near the mouth of a sick man; if the mirror be fullied, or the flame vibrates, life is concluded not to be extinguished. But these effects are often produced, after death has actually taken place; and sometimes they appear not, though the patient be still alive. When we wish to be certain of the death of any person, we apply fumes of tobacco, and other irritating bodies, to the nostrils; we endeavour

to excite the organs by violent agitations, by pricking or scarifying the hands and feet, by applying red hot iron or wax to different parts of the body, by raising loud and unusual cries, &c. But instances have occurred where all these and similar trials have proved abortive; and yet, to the astonishment of the spectators, the person supposed to be dead has afterwards recovered the powers of life.

Hence nothing can be more apparent, than that a certain condition of life has a great resemblance to actual death. Both humanity and reason, therefore, require that we should be cautious of abandoning the body, and of committing it too hastily to the grave. Neither ten, twenty, nor twenty-four hours are sufficient to distinguish a real from an apparent death; since instances are not wanting of persons returning from the tomb at the end of two and of three days. Why should we precipitate the interment of those persons, the prolongation of whose lives we most ardently desire? Why should a practice subsist, in the abolition of which all men are equally interested? Are not the frequent abuses recorded by physicians sufficient to deter us from too hasty interments? Mr Winslow * informs us, ' That the body, though living, is sometimes so completely deprived of every vital function, that it has every external appearance

* See Winslow *dissert. sur l'incertitude des signes de la mort*, p. 84.

‘ ance of death. But,’ he remarks, ‘ both religion and charity require, that a reasonable time should be allowed to discover whether any signs of life may not still manifest themselves, otherwise we become actual murderers, by burying people who are not dead. If we may credit the greatest number of authors, three days, or 72 hours, are sufficient for this purpose. If, during this period, no signs of life appear, but, on the contrary, the body begins to emit a cadaverous odour, which is an infallible mark of death, we may then bury it without scruple.’

We shall afterwards have an opportunity of mentioning the customs of different nations with regard to funerals, embalming, &c. The greatest part, even of the most savage people, pay more attention than we to their departed friends: What we esteem a ceremony only, they regard as a primary duty: They respect their dead; they clothe them; they speak to them; they recite their exploits; they praise their virtues: But we, who pretend to superior sensibility, fly from our dead, and inhumanly abandon them; we desire not to see them; we have neither the courage nor the inclination to speak of them; we even avoid such objects or situations as might recal the idea of them: We are, therefore, either more indifferent, or weaker than savages.

Having

Having thus traced the history of life and death with regard to the individual, let us now consider both in relation to the whole species. Man dies at every age; and, though the duration of his life be longer than that of most animals, yet it is unquestionably more various and uncertain. Attempts have lately been made to ascertain these uncertainties, and, by observations, to fix some standard with regard to the mortality of mankind at different periods of life. If these observations were sufficiently numerous and exact, they would be of great utility in determining the number of people, their increase, the consumption of provisions, &c. Many authors have written with ability on this subject. M. de Parcieux, of the academy of sciences, has lately published an excellent work for regulating tontins and annuities. But, as his principal object was to calculate the mortality of annuitants, and as such persons are particularly pitched upon for their apparent strength of constitution, his calculations cannot be applied to mankind in general. For the same reason, his curious tables of the mortality of the different orders of religious must be confined to their proper objects. Hally, Grant, Kersboom, Simpson, &c. have also given tables of the mortality of the human species. But, as their observations have been limited to the bills of mortality in a few parishes of London, Breslau, and other large towns, they can afford little information as to the general mortality.

mortality of mankind. To make complete tables of this kind, it is necessary to scrutinize the parish-registers, not only of London, Paris, &c. where there is a perpetual ingress of strangers, and egress of natives, but likewise those of the country, that, by comparing the results of both, general conclusions may be formed. M. Dupré de St Maur, a member of the French Academy, has executed this plan upon twelve parishes in the country of France, and three in Paris. Having obtained his permission to publish his tables, I do it the more clearly, as they are the only calculations by which the probability of human life, in general, can be ascertained with any degree of certainty.

VOL. II.

II

YEARS

Y E A R S o f L I F E.

PARISHES.	Deaths.	1	2	3	4	5
Clemont	1391	578	73	36	29	16
Brinon	1141	441	75	31	27	10
Jouy	588	231	43	11	13	5
Lestiou	223	89	16	9	7	1
Vandevre	672	156	58	18	19	10
St. Agil	954	359	64	30	21	20
Thury	262	103	31	8	4	3
St. Amant	748	170	61	24	11	12
Montigny	833	346	57	19	25	16
Villeneuve	131	14	3	5	1	1
Gouffainville	1615	565	184	63	38	34
IVry	2247	686	298	96	61	50

Total deaths 10805

Division of 10805 deaths into the years they happened. 3738 963 350 256 178

Deaths before the end of 1st, 2d, &c. years. 3738 4701 5051 5307 5485

Number of persons entered into their 1st, 2d, &c. years. 10805 7067 6104 5754 5498

St. André	1728	201	122	94	82	50
St. Hippolyte	2516	754	361	127	64	60
St. Nicolas	8945	1761	932	414	298	221

Total deaths 13189

Division of 13189 deaths into the years they happened. 2716 1415 635 444 331

Deaths before the end of 1st, 2d, &c. years. 2716 4131 4766 5210 5541

Number of persons entered into their 1st, 2d, &c. years. 13189 10473 9058 8423 7979

Division of 23994 deaths in the three parishes of Paris, and 12 country parishes. 6454 2378 985 700 509

Deaths before the end of 1st, 2d, &c. years. 6454 8832 9817 10517 11026

Number of persons entered into their 1st, 2d, &c. years. 23994 17540 15162 14177 12477

Y E A R S o f L I F E.

6	7	8	9	10	11	12	13
16	14	10	8	4	6	5	6
16	9	9	8	5	2	12	2
8	4	6	1	0	3	0	3
4	3	1	1	1	0	1	0
11	8	10	3	2	1	3	3
11	4	7	2	7	3	3	3
2	2	2	1	2	0	0	0
15	3	6	8	6	4	4	2
21	9	7	5	5	2	4	4
0	0	0	0	0	0	1	0
21	17	15	12	8	5	5	9
29	34	26	13	19	9	6	4

154	107	99	62	59	35	44	36
5639	5746	5845	5907	5960	6001	6045	6081
5320	5166	5059	4960	4898	4839	4804	4760

35	28	14	8	7	3	9	6
55	25	16	20	8	9	9	6
162	147	111	64	40	34	38	25

252	200	141	92	55	46	56	37
5793	5993	6134	6226	6281	6327	6383	6420
7648	7396	7196	7055	6963	6908	6862	6806

406	307	240	154	114	81	100	73
11432	11639	11979	12133	12247	12328	12428	12501
12968	12562	12255	12015	11861	11747.	11666	11566

Y E A R S o f L I F E.

P A R I S H E S .	D e a t h s .	14	15	16	17	18
		14	15	16	17	18
Clemont	1391	5	5	6	6	10
Brinon	1141	6	4	5	9	4
Jouy	588	3	1	6	4	4
Lestiou	223	1	1	1	1	0
Vandeuvre	672	4	5	6	3	3
St. Agil	954	3	5	2	7	8
Thury	262	0	1	0	1	1
St. Amant	748	5	1	5	3	6
Montigny	833	2	4	2	2	3
Villeneuve	131	0	1	0	2	4
Gouffainville	1615	5	5	2	5	10
IVry	2247	4	8	7	4	14

Total deaths 10805

Division of 10805 deaths into the years they happened.	38	41	42	47	67
Deaths before the end of 14th, 15th, &c. years.	6119	6160	6202	6249	6316
Number of persons entered into their 14th, 15th, &c. years.	4724	4686	4645	4603	4556
St. André	1728	7	10	13	13
St. Hippolyte	2516	7	6	5	7
St. Nicolas	8945	21	33	37	37

Total deaths 13189

Division of 13189 deaths into the years they happened.	35	49	55	57	48
Deaths before the end of 14th, 15th, &c. years.	6455	6504	6559	6616	6664
Number of persons entered into their 14th, 15th, &c. years.	6769	6734	6685	6630	6573
Division of 23994 deaths in the three parishes of Paris, and 12 country parishes.	73	90	97	104	115
Deaths before the end of 14th, 15th, &c. years.	12574	12664	12761	12865	12980
Number of persons entered into their 14th, 15th, &c. years.	11493	11420	11330	11233	11129

Y E A R S o f L I F E.

19	20	21	22	23	24	25	26
3	13	8	9	10	7	22	9
5	14	8	14	7	11	24	9
3	5	2	4	4	4	5	2
0	0	0	0	3	0	1	1
4	7	4	6	8	6	22	3
5	6	4	6	3	6	11	10
1	1	1	3	1	1	2	2
1	4	7	6	6	4	5	4
3	5	4	3	10	8	7	3
0	1	1	4	1	0	1	0
9	10	6	10	5	6	11	9
10	12	6	15	10	9	10	14

44	78	51	80	68	62	121	66
6360	6438	6480	6569	6637	6699	6820	6886
4489	4445	4367	4316	4236	4168	4106	3985
10	7	9	17	11	9	9	8
7	3	2	8	7	9	10	13
44	53	31	56	48	41	59	47

61	63	42	81	66	59	78	68
6725	6788	6830	6911	6977	7036	7114	7182
6525	6464	6401	6359	6278	6212	6153	6075

105	141	93	161	134	121	199	134
13085	13226	13319	13480	13614	13735	13934	14068
11014	10909	10768	10675	10514	10380	10259	10060

Y E A R S o f L I F E.

PARISHES.	Deaths.	27	28	29	30	31
Clemont	1391	13	10	7	24	4
Brinon	1141	7	13	6	28	6
Jouy	588	2	3	4	8	2
Lestiou	223	1	3	1	1	4
Vandevre	672	5	10	1	28	2
St. Agil	954	4	9	2	16	8
Thury	262	0	5	2	2	0
St. Amant	748	4	3	3	8	2
Montigny	833	3	3	0	6	1
Villeneuve	131	2	1	1	2	1
Gouffainville	1615	9	8	10	10	4
Ivry	2247	5	9	5	13	8

Total deaths 10805

Division of 10805 deaths into the years they happened.	55	77	42	146	42
Deaths before the end of 27th, 28th, &c. years.	6941	7018	7060	7206	7248
Number of persons entered into their 27th, 28th, &c. years.	3919	3864	3787	3745	3599

St. André	1728	17	13	11	21	6
St. Hippolyte	2516	10	10	9	7	9
St. Nicolas	8945	53	51	34	63	25

Total deaths 13189

Division of 13189 deaths into the years they happened.	80	74	54	91	40
Deaths before the end of 27th, 28th, &c. years.	7262	7336	7390	7481	7521
Number of persons entered into their 27th, 28th, &c. years.	6007	5927	5853	5799	5708

Division of 23994 deaths in the three parishes of Paris, and 12 country parishes.	135	151	96	237	82
Deaths before the end of 27th, 28th, &c. years.	14203	14354	14450	14687	14769
Number of persons entered into their 27th, 28th, &c. years.	9926	9793	9640	9544	9307

Y E A R S o f L I F E.

32	33	34	35	36	37	38	39
13	14	8	17	12	18	15	3
15	3	4	20	8	8	8	6
5	4	3	13	6	7	4	1
4	3	1	6	4	4	1	1
9	1	3	17	5	5	4	0
7	2	5	18	9	4	5	1
3	1	0	7	0	1	2	2
8	6	5	7	4	5	5	3
10	3	4	8	4	1	2	0
2	1	0	6	5	0	5	0
14	6	7	8	8	5	2	7
11	18	10	19	12	13	23	3

101	62	50	146	77	71	76	27
7349	7411	7461	7607	7684	7755	7831	7858
3557	3456	3394	3344	3198	3121	3050	2974

10	17	15	21	14	8	12	4
12	13	13	16	21	15	13	10
57	41	54	82	75	58	59	46

79	71	82	119	110	81	84	60
7600	7671	7753	7872	7982	8063	8147	8207
5668	5589	5518	5436	5317	5207	5126	5042

180	133	132	265	187	158	160	87
14949	15082	15214	15479	15666	15818	15978	16065
9245	9045	8912	8770	8515	8328	8176	8016

Y E A R S o f L I F E.

PARISHES.	Deaths.	40	41	42	43	44
Clemont	1391	41	4	10	10	6
Brinon	1141	37	6	8	3	6
Jouy	588	20	0	3	0	4
Leftiou	223	4	0	2	2	0
Vandevre	672	41	1	3	2	2
St. Agil	954	22	2	8	7	3
Thury	262	4	1	3	1	4
St Amant	748	20	1	6	2	4
Montigny	833	8	3	6	5	4
Villeneuve	131	7	0	3	1	0
Gouffainville	1615	14	10	11	4	5
Ivry	2247	27	7	19	7	14

Total deaths 10805

Division of 10805 deaths into the years they happened	245	35	82	44	52
Deaths before the end of 40th 41st, &c. years	8103	8138	8220	8264	8316
Number of persons entered into their 40th, 41st, &c. years.	2947	2702	2667	2585	2541

St André	1728	26	5	19	12	10
St. Hippolyte	2516	24	4	18	14	9
St. Nicolas	8945	109	37	73	58	45

Total deaths 13189

Division of 13189 deaths into the years they happened	159	46	110	84	64
Deaths before the end of 40th, 41st, &c. years.	8366	8412	8522	8606	8670
Number of persons entered into their 40th, 41st, &c. years	4982	4823	4777	4667	4583

Division of 23994 deaths in the three parishes of Paris, and 12 country parishes.	404	81	192	128	116
Deaths before the end of 40th, 41st, &c. years.	16469	16550	16742	16870	16986
Number of persons entered into their 40th, 41st, &c. years.	7929	7525	7444	7252	7124

Y E A R S o f L I F E.

45	46	47	48	49	50	51	52
20	5	8	5	6	31	0	5
11	5	6	9	0	23	1	3
13	3	4	2	0	20	2	3
3	3	0	3	3	5	1	1
14	5	3	1	0	31	0	2
14	1	3	3	0	24	3	9
3	0	0	0	0	3	0	0
13	3	4	6	0	23	1	4
13	6	1	6	1	10	2	5
2	1	2	3	0	7	2	1
11	9	5	12	6	15	4	9
22	10	7	12	6	24	6	14

139	51	43	62	22	216	22	56
8455	8506	8549	8611	8633	8849	8871	8927
2489	2350	2299	2256	2194	2172	1956	1934

24	21	9	13	10	24	7	18
33	14	13	15	12	20	10	19
111	54	47	68	50	120	40	59

168	89	69	96	72	164	57	96
8838	8927	8996	9092	9164	9328	9385	9481
4519	4351	4262	4193	4097	4025	3861	3804

307	140	112	158	94	380	79	152
17293	17433	17545	17703	17797	18177	18256	18408
7008	6701	6561	6449	6291	6167	5817	5738

YEARS of LIFE.

PARISHES.	Deaths.	53	54	55	56	57
Clemont	1391	5	5	14	5	5
Brinon	1141	3	2	10	6	2
Jouy	588	2	5	7	4	5
Lestiou	223	0	0	2	2	0
Vandeuvre	672	1	1	13	1	1
St. Agil	954	2	2	10	3	5
Thury	262	1	1	4	0	1
St. Amant	748	4	4	6	5	4
Montigny	833	2	5	10	3	4
Villeneuve	131	0	1	0	3	1
Gouffainville	1615	5	9	6	10	10
Irvy	2247	13	9	29	12	13

Total deaths 10805

Division of 10805 deaths into the years they happened.	38	44	111	54	51
Deaths before the end of 53d, 54th, &c. years.	8965	9009	9120	9174	9225
Number of persons entered into their 53d, 54th, &c. years.	1878	1840	1796	1685	1631

St André	1728	8	10	19	11	15
St. Hippolyte	2516	6	10	25	9	15
St. Nicolas	8945	49	46	125	56	48

Total deaths 13189

Division of 13189 deaths into the years they happened.	63	66	169	76	78
Deaths before the end of 53d, 54th, &c. years.	9544	9610	9779	9855	9933
Number of persons entered into their 53d, 54th, &c. years.	3708	3645	3579	3410	3334

Division of 23994 deaths in the three parishes of Paris, and 12 country parishes.	101	110	280	130	129
Deaths before the end of 53d, 54th, &c. years.	18509	18619	18899	19029	19158
Number of persons entered into their 53d, 54th, &c. years.	5586	5485	5375	5095	4965

Y E A R S o f L I F E.

58	59	60	61	62	63	64	65
4	4	52	2	6	5	2	5
3	0	24	1	3	4	7	7
2	0	20	0	5	2	4	5
3	0	2	0	0	1	0	3
2	0	35	0	0	1	1	5
3	3	22	3	2	7	5	7
3	1	6	0	3	2	2	2
7	2	27	0	4	3	4	12
9	2	13	3	7	5	5	7
2	1	4	3	0	1	1	2
10	3	24	6	9	7	6	13
13	3	40	3	12	12	11	14

61	19	269	21	51	50	48	82
9286	9305	9574	9595	9646	9696	9744	9826
1580	1519	1500	1231	1210	1159	1109	1061
17	11	46	11	21	19	17	20
18	12	35	7	28	21	23	25
86	48	184	42	77	71	73	95

121	71	265	60	126	111	113	140
10054	10125	10390	10450	10576	10687	10800	10940
3256	3135	3064	2799	2739	2613	2502	2389

182	90	534	81	177	161	161	122
19340	19430	19964	20045	20222	20383	20544	20766
4836	4654	4564	4030	3949	3772	3611	3450

Y E A R S o f L I F E.

PARISHES.	Deaths.	66	67	68	69	70
Clemont	1391	5	3	4	1	11
Brinon	1141	6	3	6	0	6
Jouy	588	2	1	1	1	3
Lestiou	223	1	1	0	1	0
Vandeuvre	672	3	0	2	1	9
St. Agil	954	3	6	5	2	19
Thury	262	1	3	1	0	7
St. Amant	748	7	5	6	6	18
Montigny	833	6	2	5	1	9
Villeneuve	131	3	0	1	0	4
Gouffainville	1615	17	13	15	5	16
Ivry	2247	21	5	23	7	31

Total deaths 10805

Division of 10805 deaths into the years they happened.	75	42	69	25	133
Deaths before the end of 66th, 67th, &c. years.	9901	9943	10012	10037	10170
Number of persons entered into their 66th, 67th, &c. years.	979	904	862	793	768

St. André	1728	27	21	25	9	36
St. Hippolyte	2516	19	12	20	13	35
St. Nicolas	8945	95	67	115	50	177

Total deaths 13189

Division of 13189 deaths into the years they happened.	141	100	160	72	248
Deaths before the end of 66th, 67th, &c. years.	11081	11181	11341	11413	11661
Number of persons entered into their 66th, 67th, &c. years.	2249	2108	2008	1848	1776

Division of 23994 deaths in the three parishes of Paris, and 12 country parishes.	216	142	229	97	382
Deaths before the end of 66th, 67th, &c. years.	20982	21124	21353	21450	21831
Number of persons entered into their 66th, 67th, &c. years.	3228	3012	2870	2641	2544

Y E A R S o f L I F E.

71	72	73	74	75	76	77	78
1	3	1	3	5	1	1	2
2	12	2	0	4	2	0	3
1	2	0	1	1	0	0	0
0	2	0	0	0	0	0	0
1	4	0	0	3	0	1	0
1	11	5	5	8	0	3	4
0	2	1	0	0	0	1	0
3	10	2	2	18	2	4	4
2	8	3	2	9	1	4	2
0	3	0	0	0	0	2	1
8	22	12	12	16	6	6	8
6	21	11	19	24	12	11	14

25	100	37	44	88	24	33	38
10195	10295	10332	10376	10464	10488	10521	10559
635	610	510	473	429	341	317	284
9	25	14	19	20	16	10	25
10	28	5	15	23	11	18	15
64	118	53	90	127	63	59	69

83	171	72	124	170	90	87	109
11744	11915	11987	12111	12281	12371	12458	12567
1528	1445	1274	1202	1078	908	818	731
108	271	109	168	258	114	120	147
21939	22210	22319	22487	22745	22859	22979	23126
2160	2155	1784	1675	1507	1249	1135	1015

Y E A R S o f L I F E.

PARISHES.	Deaths.	79	80	81	82	83
Clemont	1391	2	6	0	0	0
Brinon	1141	0	3	1	0	0
Jouy	588	0	2	0	0	0
Leftiou	223	0	1	0	0	0
Vandeuvre	672	0	7	0	0	0
St. Agil	954	0	6	0	0	0
Thury	262	0	3	0	0	0
St. Amant	748	2	17	1	3	1
Montigny	833	0	5	1	4	1
Villeneuve	131	1	1	0	0	0
Gouffainville	1615	1	17	6	9	5
IVry	2247	9	19	7	14	4

Total deaths 10805

Division of 10805 deaths into the years they happened. { 15 89 16 30 11

Deaths before the end of 79th, 80th, &c. years. { 10574 10663 10679 10709 10720

Number of persons entered into their 79th, 80th, &c. years. { 246 231 142 126 96

St. André - 1728 8 17 4 10 8

St. Hippolyte - 2516 8 18 4 5 16

St. Nicolas - 8945 30 121 32 41 37

Total deaths 13189

Division of 13189 deaths into the years they happened. { 46 156 40 56 61

Deaths before the end of 79th, 80th, &c. years. { 12613 12769 12809 12865 12926

Number of persons entered into their 79th, 80th, &c. years. { 622 576 420 380 324

Division of 23994 deaths in the three parishes of Paris, and 12 country parishes. { 61 245 56 86 72

Deaths before the end of 79th, 80th, &c. years. { 23187 23432 23488 23574 23646

Number of persons entered into their 79th, 80th, &c. years. { 868 807 562 506 420

Y E A R S of L I F E.

84 85 86 87 88 89 90 91

3	0	1	0	0	1		
0	0	0	0	1			
0	1						
0	0	0	1	1			
0	0	0	0	0	0	2	0
3	4	0	1	2	0	4	1
1	0	0	0	0	0	1	
0	0	0	0	0	1		
7	2	4	4	2	2		
7	5	4	2	3	1	2	0

21 12 9 8 9 5 9 1

10741 10753 10762 10770 10779 10784 10793 10794

85 64 52 43 35 26 21 12

7 3 7 4 5 2 4 0

4 10 4 1 4 2 2 2

25 35 19 20 25 4 17 5

36 48 30 25 34 8 23 7

12962 13010 13040 13065 13099 13107 13130 13137

263 227 179 149 124 90 82 59

57 50 39 33 43 13 32 8

23703 23763 23802 23835 22878 23891 23923 23931

348 291 231 192 159 116 103 71

Y E A R S o f L I F E.

PARISHES.	Deaths.	92	93	94	95	96
Clemont	-	1391				
Brinon	-	1141				
Jouy	-	588				
Lestiou	-	223				
Vandeuvre	-	672				
St. Agil	-	954	0	0	0	0
Thury	-	262				
St. Amant	-	748	1	0	0	2
Montigny	-	833				
Villeneuve	-	131				
Gouffainville	-	1615				
Ivry	-	2247	2	0	0	1
Total deaths		10805				

Division of 10805 deaths into the years they happened.	3	0	0	3	1
Deaths before the end of 92d, 93d, &c. years.	10797	10797	10797	10800	10801
Number of persons entered into their 92d, 93d, &c. years.	11	8	8	8	5

St. André	-	1728	2	1	2	0	1
St. Hippolyte	-	2516	2	1	1	2	1
St. Nicolas	-	8945	9	5	4	5	2
Total deaths		13189					

Division of 13189 deaths into the years they happened.	13	7	7	7	7	4
Deaths before the end of 92d, 93d, &c. years.	13150	13157	13164	13171	13175	
Number of persons entered into their 92d, 93d, &c. years.	52	39	32	25	18	

Division of 23994 deaths in the three parishes of Paris, and 12 country parishes	16	7	7	10	5
Deaths before the end of 92d, 93d, &c. years.	23947	23954	23961	23971	23976
Number of persons entered into their 92d, 93d, &c. years.	63	47	41	33	23

Y E A R S o f L I F E.

PARISHES.	Deaths:	97	98	99	100
Clenmont	-	1391			
Brinon	-	1141			
Jouy	-	588			
Lestiou	-	223			
Vandeuvre	-	672			
St. Agil	-	954	0	0	0
Thury	-	262			
St. Amant	-	748	0	3	
Montigny	-	833			
Villeneuve	-	131			
Goussainville	-	1615			
Ivry	-	2247			

Total deaths 10805

Division of 10805 deaths into
the years they happened. } 0 3 0 1

Deaths before the end of 97th, } 10801 10804 10804 10805
98th, &c. years. }

Number of persons entered into
their 97th, 98th, &c. years. } 4 4 1 1

St. André - 1728 1 0 0 0

St. Hippolyte - 2516 0 1 1 0

St. Nicolas - 8945 1 4 1 4

Total deaths 13189

Division of 13189 deaths into
th. years they happened. } 2 5 1 4

Deaths before the end of 97th, } 13177 13182 13183 13187
98th, &c. years. }

Number of persons entered into
their 97th, 98th, &c. years. } 14 12 7 6

Division of 23994 deaths in the
three parishes of Paris, and
12 country parishes. } 2 8 1 5

Deaths before the end of 97th, } 23978 23985 23987 23992
98th, &c. years. }

Number of persons entered into
their 97th, 98th, &c. years. } 18 16 8 7

Many useful conclusions might be drawn from the above tables of M. Dupré. But I shall confine myself to those which regard the probabilities of the duration of life. In the columns under the years, 10, 20, 30, 40, 50, 60, 70, 80, and other round numbers, as 25, 35, &c. there are, in the country-parishes, more deaths than in the preceding or subsequent columns. This is owing to the ages not being justly registered, most country-people being unable to ascertain their ages within less than two or three years. If they die at 58 or 59, they are registered at 60, and so of other round numbers. But this irregularity gives rise to no great inconvenience, as it can easily be corrected by the manner in which the numbers succeed each other in the tables.

It appears from the tables of the country-parishes, that one half of the children die nearly about the end of the fourth year; but, from the Paris table, 16 years are necessary to produce the same effect. This great difference proceeds from a general practice of the Parisians, who send their children to be nursed in the country, which necessarily increases the number of deaths during the first years of infancy. In the following calculation, I have estimated the probabilities of the duration of life from a combination of both tables; which must, therefore, make a very near approach to the truth.

T A B L E, showing the probabilities of the duration of human life.

Age.	Duration of life.		Age.	Duration of life.		Age.	Duration of life.	
Years.	Years.	Months.	Years.	Years.	Months.	Years.	Years.	Months.
0	8	0	29	28	6	58	12	3
1	33	0	30	28	0	59	11	8
2	38	0	31	27	6	60	11	1
3	40	0	32	26	11	61	10	6
4	41	0	33	26	3	62	10	0
5	41	6	34	25	7	63	9	6
6	42	0	35	25	0	64	9	0
7	42	3	36	24	5	65	8	6
8	41	6	37	23	10	66	8	0
9	40	10	38	23	3	67	7	6
10	40	2	39	22	8	68	7	0
11	39	6	40	22	1	69	6	7
12	38	9	41	21	6	70	6	2
13	38	1	42	20	11	71	5	8
14	37	5	43	20	4	72	5	4
15	36	9	44	19	9	73	5	0
16	36	0	45	19	3	74	4	9
17	35	4	46	18	9	75	4	6
18	34	8	47	18	2	76	4	3
19	34	0	48	17	8	77	4	1
20	33	5	49	17	2	78	3	11
21	32	11	50	16	7	79	3	9
22	32	4	51	16	0	80	3	7
23	31	10	52	15	6	81	3	5
24	31	3	53	15	0	82	3	3
25	30	9	54	14	6	83	3	2
26	30	2	55	14	0	84	3	1
27	29	7	56	13	5	85	3	0
28	29	0	57	12	10			

From this table, it appears, that a new born infant, or a child of 0 age, has an equal chance of living 8 years ; that a child of 1 year will live 33 more ; that a child of 2 years will live 38 more ; that a man of 20 years will live 33 and 5 months more ; and that a man of 30 years will live 28 more, &c.

It may be farther observed, 1. That 7 years is the age at which the longest duration of life is to be expected ; for there is then an equal chance of surviving 42 years 3 months ; 2. That, at 12 years, one fourth of life is expired, since we have no reason to hope for above 38 or 39 years more ; 3. That, at 28 or 29 years, we have lived one half of our days, since there are only 28 more to be expected ; and, lastly, That, at the age of 50, three fourths of life are gone, the remaining chance extending only to 16 or 17 years longer.

But these physical truths, however mortifying, may be alleviated by moral considerations. The first 15 years of our existence may be regarded as nothing : Every thing that passes during this long period, is either obliterated from the memory, or has so little connection with the views and objects which afterwards occupy our attention, that it ceases entirely to be interesting. The train of our ideas, and even the nature of our existence, suffer a total change. We begin not to live, in a moral sense, till after we have learned

learned to arrange our thoughts, to direct them towards futurity, to assume a kind of consistency of character similar to that state at which we are ultimately destined to arrive. Considering the duration of life in this point of view, which is the only real one, at the age of 25, we have passed one fourth of our days, at the age of 38, one half, and, at the age of 56, three fourths.

END OF VOLUME II.

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